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Aggregate Resources Inventory of the Sault Ste. Marie Area Algoma District

By Staff of the Engineering and Terrain Geology Section, Ontario Geological Survey

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Aggregate Resources Inventory of the Sault Ste. Marie Area Algoma District

by
Staff of the Engineering and Terrain Geology Section

1. Project supervisor: Dale W. Scott; field work and report by I. Szoke; compilation and drafting by staff of the Aggregate Assessment Office. The Mineral Resources Staff of Sault Ste. Marie District and Northeastern Region of the Ministry of Natural Resources assisted in the collection of data, field checking and review of this report.

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Abstract

This report includes both an inventory and evaluation of sand and gravel as well as bedrock resources for the City of Sault Ste. Marie and seven townships surrounding the city. The report is based on previous studies in the area and a detailed field assessment undertaken by a two-man field party during the summer of 1983.

Within the Sault Ste. Marie area, two large areas containing significant amounts of high quality sand and gravel have been selected for possible resource protection at the primary level of significance. Selected Sand and Gravel Resource Area 1 is a large glaciolacustrine beach-glaciolacustrine deltaic complex which lies along the Precambrian bedrock escarpment in the City of Sault Ste. Marie. This deposit complex is the most important natural aggregate source within the project area and contains an estimated 275 million tons (249 million tonnes) of high quality sand and gravel suitable for a full range of road-building and construction aggregate products.

Selected Sand and Gravel Resource Area 2 is located on the Precambrian bedrock highland in Aweres Township. This deposit also contains high quality, mostly coarse gravel. Because of extensive residential and other developments in this deposit area, the remaining resources available for extraction are estimated to be only 42 million tons (38 million tonnes).

The bedrock materials underlying the Sault Ste. Marie area are of Cambrian or Precambrian age. The lowland areas are underlain by the red sandstone of the Jacobsville Formation (Cambrian). Although this sandstone is quarried for ornamental applications, it is not suitable for use as crushed aggregate. The complex bedrock types underlying the highland areas are of Precambrian age and include igneous, metasedimentary and volcanic rocks. Drift cover is thin and irregular leaving large areas of exposed bedrock on the highlands. Future quarrying potential for certain types of bedrock exists, however, more detailed investigation will be required to delineate suitable quarry sites.

Alternate sources of aggregate for the Sault Ste. Marie area include the high quality sand and gravel which is draglined from the St. Marys River and the blast furnace slag which is produced in large quantities by Algoma Steel Corporation Ltd.

Selected Resource Areas are not intended to be permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

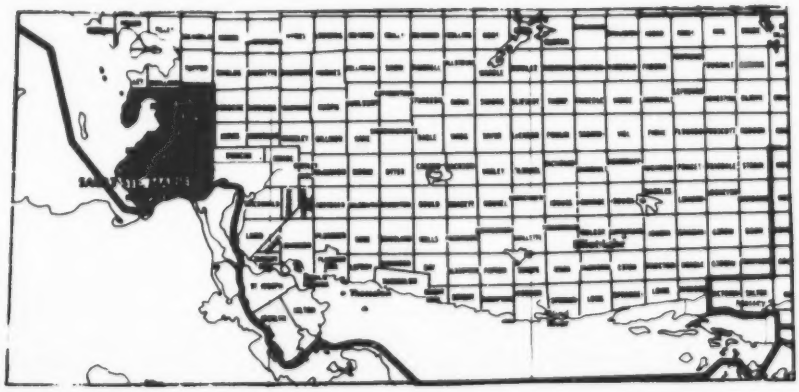

Figure 1. Key Map Showing the Location of the Sault Ste. Marie Area.
Scale 1:1 584 000.

Introduction

Mineral aggregates, which include bedrock-derived crushed stone as well as naturally formed sand and gravel, constitute the major raw material in Ontario's road-building and construction industries. Very large amounts of these materials are used each year throughout the Province. For example, in 1981, the total tonnage of mineral aggregate extracted was 121 million tons (110 million tonnes), greater than that of any other metallic or nonmetallic commodity mined in the Province (Ontario Ministry of Natural Resources 1982).

Although mineral aggregate deposits are plentiful in Ontario, they are fixed-location, nonrenewable resources which can be exploited only in those areas where they occur. Mineral aggregates are characterized by their high bulk and low unit value so that the economic value of a deposit is a function of its proximity to a market area as well as its quality and size. The potential for extractive development is usually greatest in urban fringe areas where land use competition is extreme. For these reasons, the availability of adequate resources for future development is now being threatened in some areas.

Comprehensive planning and resource management strategies are required to make the best use of available resources, especially in those areas experiencing rapid development. Such strategies must be based on a sound knowledge of the total mineral aggregate resource base at both local and regional levels. The purpose of the Aggregate Resources Inventory is to provide the basic geological information required to include potential mineral aggregate resource areas in planning strategies and official plans. The reports should form the basis for discussion on those areas best suited for possible extraction. The aim is to assist decision-makers in protecting the public well-being by ensuring that adequate resources of mineral aggregate remain available for future use.

This report is a technical background document, based for the most part on geological information and interpretation. It has been designed as a component of the total planning process and should be used in conjunction with other planning considerations, to ensure the best use of a municipality's resources.

The report includes an assessment of sand, gravel and crushed bedrock. The most recent information available has been used to prepare the report. As new information becomes available, revisions may be necessary.

Part I — Inventory Methods

FIELD AND OFFICE METHODS

The methods used to prepare the report primarily involve the interpretation of published geological data such as bedrock and surficial geology maps and reports (see References) as well as field examination of potential resource areas. Field methods included the examination of natural and man-made exposures of granular material. Most observations were made at quarries and sand and gravel pits located from records held by the Ontario Ministry of Transportation and Communications (M.T.C.), the Ontario Geological Survey, and by Regional and District Offices of the Ontario Ministry of Natural Resources. Observations made at pit sites included estimates of the total face height and the proportion of gravel- and sand-sized fragments in the deposit. Observations were also made of the shape and lithology of the particles. These characteristics are important in estimating the quality and quantity of the aggregate. In areas of limited exposure, test pitting, soil probing and hand-augering techniques were used to assess subsurface materials. Airphotos at various scales were used to determine the continuity of deposits, especially in areas where information is limited.

Deposits with potential for further extractive development or those where existing data are scarce, were studied in greater detail. Representative layers in these deposits were sampled in 25- to 100- pound (11 to 45 kg) units from existing pit faces. The samples were analyzed for grain size distribution and in most cases for petrographic assemblage. Analyses were performed in the laboratories of the Soils and Aggregates Section, Engineering Materials Office, Ontario Ministry of Transportation and Communications. Areas of limited subsurface exposure were investigated by auger drilling in 1978 and seismic refraction geophysical surveys in 1983. The results of these investigations are included in Tables 7 and 8 in Part III.

In the office, the field data were supplemented by pit information on file with the Soils and Aggregates Section of the Ontario Ministry of Transportation and Communications. Data contained in these files include field estimates of the depth, composition and "workability" of deposits as well as laboratory analyses of the physical properties and chemical suitability of the aggregate. Information concerning the development history of the pits and acceptable uses of the aggregate is also recorded. The locations of additional sources were obtained from records held by Regional and District Offices of the Ontario Ministry of Natural Resources. The cooperation of the above- named groups in the compilation of inventory data is gratefully acknowledged.

Water well records, held by the Ontario Ministry of the Environment, were used in some areas to corroborate thickness estimates or to indicate the presence of buried granular material. These records were used in conjunction with other evidence. Topographic maps of the National Topographic System, at a scale of 1:50 000, were used as a compilation base for the field and office data. The information was then transferred to a base map, also at a scale of 1:50 000, prepared by the Cartography Section of the Lands and Waters Group, Ontario Ministry of Natural Resources, for presentation in the report.

RESOURCE TONNAGE CALCULATION TECHNIQUES

SAND AND GRAVEL RESOURCES

Once the interpretative boundaries of the aggregate units have been drawn, quantitative estimates of the possible resources available can be made. Generally, the volume of a deposit can be calculated if its areal extent and average thickness are known or can be estimated. The computation methods used are as follows. First, the area of the deposit, as outlined on the final base map, is calculated in acres. The thickness values used are an approximation of the deposit thickness, based on the face heights of pits developed in the deposit or on subsurface data such as test holes and water well logs. Original tonnage values can then be calculated by multiplying the volume of the deposit by 2500 (the density factor). This factor is approximately the number of tons in a one-foot (0.3 m) thick layer of sand and gravel, one acre (0.4 ha) in extent, assuming an average density of 110 pounds per cubic foot (1766 kg per cubic metre).

Tonnage = Area x Thickness x Density Factor

Tonnage calculated in this manner must be considered only as an estimate. Furthermore, such tonnages represent amounts that existed prior to any extraction of material (i.e. original tonnage) (Table 1, Column 4).

The Selected Sand and Gravel Resource Areas in Table 3 are calculated in the following way. Two successive subtractions are made from the total area. Column 3 accounts for the number of acres unavailable because of the presence of permanent cultural features and their associated setback requirements. Column 4 accounts for those areas that have previously been extracted. The remaining figure is the area of the deposit currently available for extraction (Column 5). The available area is then multiplied by the estimated deposit thickness and the density factor (Column 5 x Column 6 x 2500) to give an estimate of the sand and gravel tonnage (Column 7) presently available for extractive development and/or resource protection.

Reserve estimates are calculated for deposits of primary significance. Reserve estimates for deposits of secondary and tertiary significance are not calculated in Table 3, however, the aggregate potential of these deposits is discussed in the report.

BEDROCK RESOURCES

The method used to calculate resources of bedrock-derived aggregate is much the same as that described above. The areal extent of bedrock formations overlain by less than 25 feet (8 m) of unconsolidated overburden is determined from bedrock geology maps and from the interpretation of available subsurface data. The measured extent of such areas is then multiplied by the estimated quarriable thickness of the rock unit. In most cases a standardized estimate of a quarriable thickness of 60 feet (18 m) is used. Although the thicknesses of the Precambrian bedrock units in northern Ontario are all probably considerably greater, the 60-foot (18 m) value is considered an appropriate estimate of the maximum thickness of material that can be economically and technologically extract-

ed from a given quarry face. Volume estimates are then multiplied by 3700 (the estimated average weight, in Imperial tons, of a one-foot (0.3 m) thick section of Precambrian rock one acre (0.4 ha) in extent, assuming a bulk density of 170 pounds per cubic foot (2729 kg per cubic metre)). For Cambrian rocks a factor of 3200 was used, representing a bulk density of 146 pounds per cubic foot (2344 kg per cubic metre).

UNITS AND DEFINITIONS

Although most of the measurements and other primary data available for resource tonnage calculations are given in Imperial units, Metric units have also been given in the text and on the tables which accompany the report. The Metric equivalent of the data is shown in brackets after or directly below the corresponding Imperial figures. Data are generally rounded off in accordance with the Ontario Metric Practice Guide (Metric Committee 1975).

The tonnage estimates made for sand and gravel as well as bedrock- derived aggregate are termed possible resources in accordance with terminology of the Ontario Resource Classification Scheme (Robertson 1975, p.7) and with the Association of Professional Engineers of Ontario (1976) (see Glossary, Appendix B).

Part II — Data Presentation and Interpretation

Three maps, each portraying a different aspect of the aggregate resources in the study area, accompany the report. Map 1, "Distribution of Sand and Gravel Deposits", gives a comprehensive inventory of the sand and gravel resources in the report area. Map 2, "Selected Sand and Gravel Resource Areas", shows those deposits which are considered to represent the largest and/or highest quality resources in the area. Map 3, "Bedrock Resources", shows the distribution of bedrock lithologies, the distribution of overlying unconsolidated sediments, and identifies the Selected Bedrock Resource Areas.

MAP 1: DISTRIBUTION OF SAND AND GRAVEL DEPOSITS

Map 1 is derived directly from existing surficial geology maps of the area or from airphoto interpretation in areas where surficial mapping is incomplete. The map shows the extent and quality of sand and gravel deposits within the study area and the present level of extractive activity.

On the map, gravel deposits are indicated by dark brown shading while sand deposits are shaded light brown. The present level of extractive activity is also indicated. Pits are shown by a solid dot and identified by a number which refers to the pit descriptions in Table 2. Each description notes the owner and location of the pit, as well as the estimated face height, percentage gravel and pit status.

Map 1 also presents a summary of available information related to the quality of aggregate contained in all the known aggregate deposits in the study area. Much of this information is contained in the symbols which are found on the map. The Deposit Symbol appears for each mapped deposit and summarizes important genetic and textural data. The Texture Symbol is a circular proportional diagram which displays the grain size distribution of the aggregate in areas where bulk samples were taken.

DEPOSIT SYMBOL

The Deposit Symbol is similar to those used in soil mapping and land classification systems commonly in use in North America. The components of the symbol indicate the gravel content, thickness of material, origin (type), and quality limitations for every deposit shown on Map 1. These components are illustrated by the following example:

This symbol identifies an outwash deposit 10 to 20 feet (3 to 6 m) thick containing more than 35 percent gravel. Excess silt and clay may limit uses of the aggregate in the deposit.

The "gravel content" and "thickness class" are basic criteria for distinguishing different deposits. The "gravel content" symbol is an upper case "S" or "G". The "S" indicates that the deposit is generally "sandy" and that gravel-sized aggregate makes up less than 35 percent of the whole deposit. "G" indicates that the deposit contains more than 35 percent gravel.

The "thickness class" indicates a depth range which is related to the potential resource tonnage for each deposit. Four thickness class divisions have been established as shown in the legend for Map 1.

Two smaller sets of letters, divided from each other by a horizontal line, follow the thickness class number. The upper series of letters identifies the geologic deposit type (the types are summarized with respect to their main geologic and extractive characteristics in Appendix C) and the lower series of letters identifies the main quality limitations that may be present in the deposit as discussed in the next section.

TEXTURE SYMBOL

The Texture Symbol provides a more detailed assessment of the grain size distribution in deposits where samples were taken for analysis during field study. The information from which these symbols are derived has been plotted on grain size distribution graphs. The relative amounts of gravel, sand, and silt and clay in the sampled material are shown graphically by the subdivision of a circle into proportional segments. The following example shows a hypothetical sample consisting of 30 percent gravel, 60 percent sand, and 10 percent silt and clay:

Test hole locations are shown on Map 1 by a solid drill hole symbol. Geophysics traverse line locations are shown by a bar symbol on Map 1.

MAP 2: SELECTED SAND AND GRAVEL RESOURCE AREAS

Map 2 is an interpretative map derived from an evaluation of the deposits shown on Map 1. The deposits identified on Map 2 are those which are considered to be important in ensuring an adequate resource base for the future.

All the selected sand and gravel resource areas are first delineated by geological boundaries and then classified into three levels of significance: primary, secondary, and tertiary. Each area of primary significance is assessed as to its probable relative value as a resource in the report area and is given a deposit number which denotes its ranking order in that area. All such deposits are shown by dark red shading on Map 2.

Deposits of secondary significance are not ranked numerically in this report, but are indicated by light red shading on Map 2. Such deposits are believed to contain significant amounts of sand and gravel. Although deposits of secondary significance are not considered to be the "best" resources in the report area, they may contain large quantities of sand and gravel and should be considered as part of the aggregate supply of the area.

Areas of tertiary significance are outlined on the map by a solid line but have no shading. They are neither rated nor considered to be important resource areas because of their low available resources, or because of possible difficulties in extraction. Such areas may be useful for local needs but are unlikely to support large-scale development.

Selected Sand and Gravel Resource Areas are not permanent, single, land use units which must be incorporated in an official planning document. They represent areas in which a major resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

The process by which deposits are evaluated and selected involves the consideration of two sets of criteria. The main selection criteria are site specific, related to the characteristics of individual deposits. Factors such as deposit size, aggregate quality, and deposit location and setting are considered in the selection of those deposits best suited for extractive development. A second set of criteria involves the assessment of local aggregate resources in relation to the quality, quantity, and distribution of resources in the region in which the report area is located. The intent of such a process of evaluation is to ensure the continuing availability of sufficient resources to meet possible future demands.

SITE SPECIFIC CRITERIA

Deposit Size

Ideally, selected deposits should contain available sand and gravel resources large enough to support a commercial pit operation using a stationary or portable processing plant. In practice, much smaller deposits may be of significant value depending on the overall reserves in the rest of the municipality. Generally, deposits in Class 1, i.e. those thicker than 20 feet (6 m) and containing more than 35 percent crushable gravel, are considered to be most favourable for commercial development. Thinner deposits may be valuable in municipalities with low total resources.

Aggregate Quality

The limitations of natural aggregates for various uses result from variations in the lithology of the particles composing the deposit and from variations in the size distribution of these particles.

Four indicators of the quality of aggregate may be included in the symbol for each deposit on Map 1. They are: gravel content (G or S), fines (C), oversize (O) and lithology (L).

Three of the indicators deal with grain size distribution. The gravel content, (G or S), indicates the suitability of aggregate for various uses. Deposits containing at least 35 percent gravel in addition to a minimum of 20 percent material greater than the 26.5 mm sieve are considered to be the most favourable extractive sites, since this content is the minimum from which crushed products can be economically produced.

Excess fines (high silt and clay content) may severely limit the potential use of an aggregate. Fines content in excess of 10 percent may impede drainage in road sub-base aggregate and render it more susceptible to the effects of frost action. In asphalt aggregate, excess fines hinder the bonding of particles. Deposits known to have a high fines content are indicated by a "C" in the quality portion of the Deposit Symbol.

Deposits containing more than 20 percent oversize material (greater than 8 inches (20 cm) in diameter) may also have use limitations. The oversize component is unacceptable for all concrete aggregate and for road-building aggregate, so it must be either crushed or removed during processing. Deposits known to have an appreciable oversize component are indicated by an "O" in the quality portion of the Deposit Symbol.

The other indicator of the quality of an aggregate is lithology. Just as the unique physical and chemical properties of bedrock types determine their value for use as crushed rock, so do various lithologies of particles in a sand and gravel deposit determine its suitability for various uses. The presence of objectionable lithologies such as chert, siltstone, and shale, even in relatively small amounts, can result in a reduction in the quality of an aggregate, especially for high quality uses such as concrete and asphalt. Similarly, highly weathered, very porous and friable rock can restrict the quality of an aggregate. Deposits known to contain objectionable lithologies are indicated by an "L" in the quality component of the Deposit Symbol.

If the Deposit Symbol indicates either "C", "O", or "L" or any combination, the quality of the deposit is considered to be reduced for some uses of the aggregate. No attempt has been made to quantify the degree of limitation imposed. Assessment of the four indicators is made from published data, from data contained in files of the Ontario Ministry of Transportation and Communications and the Engineering and Terrain Geology Section of the Ontario Geological Survey, and from field observations.

Analyses of unprocessed samples obtained from test holes or pits have been plotted on grain size distribution graphs. On the graphs are the gradation specification envelopes for Ontario Ministry of Transportation and Communications' products: Granular Base Course A, B and C; Hot-Laid Asphaltic Sand Nos. 1, 2, 3, 4, 5, 6 and 8; and Concrete Sand. By plotting the gradation curves with respect to the specification envelopes, it can be determined how well the unprocessed sampled material meets the criteria for each product.

Location and Setting

The location and setting of a resource area have a direct influence on its value for possible extraction. The evaluation of a deposit's setting is made on the basis of natural and man-made features which may limit or prohibit extractive development.

First, the physical context of the deposit is considered. Deposits with some physical constraint on extractive development, such as thick overburden or high water table, are less valuable resource areas because of the difficulties involved in resource recovery. Second, permanent man-made features, such as roads, railways, powerlines, and housing developments, which are built on a deposit, may prohibit its

extraction. The constraining effect of legally required setbacks surrounding such features is included in the evaluation. A quantitative assessment of these constraints can be made by measurement of their areal extent directly from the topographic maps. The area rendered unavailable by these features is shown for each resource area in Table 3 (Column 3).

The assessment of sand and gravel deposits and bedrock resource areas with respect to local land use and to private land ownership is an important part of the general evaluation process. These aspects of the evaluation process are not considered further in this report, but readers are encouraged to discuss them with personnel of the pertinent District Office of the Ontario Ministry of Natural Resources.

REGIONAL CONSIDERATIONS

In selecting sufficient areas for resource development, it is important to assess both the local and the regional resource base, and to forecast future production and demand patterns.

Some appreciation of future aggregate requirements in an area may be gained by assessing its present production levels and by forecasting future production trends. Such an approach is based on the assumptions that production levels in an area closely reflect the demand and that the present production "market share" of an area will remain roughly at the same level.

The aggregate resources in the region surrounding a municipality should be assessed in order to properly evaluate specific resource areas and to adopt optimum resource management plans. For example, a municipality that has large resources in comparison to its surrounding region constitutes a regionally significant resource area. Municipalities with high resources in proximity to large demand centres, such as metropolitan areas, are special cases.

Although an appreciation of the regional context is required to develop comprehensive resource management techniques, such detailed evaluation is beyond the scope of this report. The selection of resource areas made in this study is based primarily on geological data or on considerations outlined in the preceding section.

MAP 3: BEDROCK RESOURCES

Map 3 is an interpretative map derived from bedrock geology maps, water well data from the Ontario Ministry of the Environment, drilling assessment data from the Ontario Ministry of Natural Resources and from the Northern Ontario Engineering Geology Terrain Studies produced for the Ontario Geological Survey. Map 3 is based on concepts similar to those outlined for Maps 1 and 2, but displays both the inventory and evaluation on the one map.

The geological boundaries of the bedrock units are shown by a dashed line. Areas where bedrock outcrops, or is within 3 feet (1 m) of the ground surface are indicated by dark blue shading. These areas may constitute potential resource areas of primary significance, based on their easy access. Areas where the bedrock is covered by 3 to 25 feet (1 to 8 m) of drift are indicated by light blue shading. Quarrying is possible in this depth of overburden and these may also represent potential resource areas. Outside the delineated areas of thin drift cover, the bedrock is generally overlain by more than 25 feet (8 m) of drift. These areas constitute resources which have extractive value only in specific circumstances and it is unlikely these areas will constitute resource areas of economic significance.

Other inventory information presented on Map 3 is designed to give an indication of the present level of extractive activity in the report area. All known quarries are shown by a quarry symbol and identified by a number which refers to the quarry descriptions in Table 5. Each description notes the owner, location and an estimate of face height. One additional symbol appears on the map: an open dot indicates the location of a selected drill hole which penetrates bedrock. The overburden thickness is shown in feet beside the open dot.

SELECTION CRITERIA

Criteria equivalent to those used for sand and gravel deposits are used to select bedrock areas most favourable for extractive development.

The evaluation of bedrock resources is made primarily on the basis of performance and suitability data established by laboratory testing at the Ontario Ministry of Transportation and Communications. The main characteristics of the bedrock units found in the study area are summarized in Appendix D.

Deposit "size" is related directly to the areal extent of thin drift cover overlying favourable bedrock formations. Quality of the aggregate derived from specific bedrock units is established by the performance standards previously mentioned. Location and setting criteria and regional considerations are identical to those for sand and gravel deposits.

SELECTED RESOURCE AREAS

Selection of bedrock resource areas has been restricted to a single level of significance. Two factors support this approach. First, the areal extent of a given quarry operation is much smaller than that of a sand and gravel pit producing an equivalent tonnage of material, and second, since crushed bedrock has a higher unit value than sand and gravel, longer haul distances can be considered. These factors allow the identification of alternative sites having similar development potential. The selected areas, if applicable, are shown on Map 3 by a line pattern and the calculated available tonnages are given in Table 6.

It should be stressed that the Precambrian Shield rocks in northern Ontario are generally more complex and variable than the Paleozoic rocks of southern Ontario. They often show wide variations in mineralogy, texture (grain size) and degree of weathering, even within specific rock types and over relatively short distances. As these factors are considered important in determining the suitability of the bedrock for use as aggregate, the aggregate potential may also vary considerably from location to location.

Careful selection is especially important if the bedrock is to be used as concrete aggregate. Deleterious chemical reactions may develop in the concrete

which can lead to its eventual deterioration. Fortunately, these chemical reactions should not influence the use of bedrock-derived aggregate for hot-laid asphaltic and road-base material. However, highly weathered, very porous and friable rock should be avoided for all uses.

For these reasons, all of the area selected as a bedrock resource should not be considered as fully acceptable for aggregate use. The selected areas do, however, represent areas in which the probability of finding a supply of acceptable aggregate is considered the most likely.

Selected Bedrock Resource Areas shown on Map 3 are not permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major bedrock resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

Part III — Assessment of Aggregate Resources in the Sault Ste. Marie Area

LOCATION AND POPULATION

The Sault Ste. Marie Area occupies approximately 189 000 acres (76 000 ha) in the southern part of Algoma District in northern Ontario. The report area includes the City of Sault Ste. Marie, the Corporation of the Township of Prince and the unincorporated geographic townships of Dennis, Pennefather, Aweres, Kars, Fenwick and Van Koughnet. The report area is covered by the Pancake Bay (41 K/15), Searchmont (41 K/16), Sault Ste. Marie (41 K/9) and the Ile Parisienne (41 K/10) map sheets of the National Topographic System at a scale of 1:50 000.

The City of Sault Ste. Marie, the administrative centre for the District of Algoma, is also the largest population centre providing trade, retail, manufacturing and recreational facilities for the local and nearby population. Several small settlements acting as satellite communities to the city are scattered along the major highways in the report area. The settlements are Heyden, Island Lake, Kirby's Corner, Goulais River, Goulais Bay and Karalash Corners. These settlements have gradually changed from being mainly lumbering communities to being more rural-residential, seasonal- recreational and, to a limited extent, farming communities.

In 1982, the combined population of the report area was 82 902 (Ontario Ministry of Municipal Affairs and Housing 1983; Ontario Ministry of Revenue 1982). Over a period of four years, from 1979 to 1982, the population increased by approximately 3 percent. Population growth was also approximately 3 percent for the City of Sault Ste. Marie, with 95 percent of the area's total population living within the city itself (Ontario Ministry of Intergovernmental Affairs 1979, 1980; Ontario Ministry of Muncipal Affairs and Housing 1983).

The above figures indicate a slow but steady growth for the City of Sault Ste. Marie and the surrounding townships. Possible future expansion of the industrial sector could increase the present rate of growth through in-migration (Sniezek 1976). In view of the positive population growth, demand for sand, gravel and crushed stone supplies for road-building and construction aggregate may steadily increase in the future.

The Trans Canada Highway (King's Highway 17) and Secondary Highways 550, 552, 556 and 565 provide excellent access to the Sault Ste. Marie area. In addition, there are numerous gravel-surfaced roads and old logging roads which allow access to the more remote areas. Rail access is provided by lines of the Canadian Pacific and Algoma Central Railways. The Sault Ste. Marie International Bridge spans the St. Marys River to join with the highway system of the State of Michigan, U.S.A. The Sault Ship Canal allows large ships to pass from Lake Superior to the lower Great Lakes. There are also extensive docking facilities available along the St. Marys River in the vicinity of the City of Sault Ste. Marie.

PHYSIOGRAPHY AND SURFICIAL GEOLOGY

The most prominent physiographic features of the Sault Ste. Marie area include: the terraced low-lying area along the St. Marys River; the meandering Goulais River and the surrounding lowland which extends through Fenwick and Van Koughnet Townships; and the rugged high hills of the Gros Cap Batholith (Robertson and Card 1972). The Gros Cap Batholith is a large granitic highland which extends from Goulais Bay across the central part of the project area. In the Township of Prince and the northern part of the City of Sault Ste. Marie, the highland displays a distinctive escarpment that extends from Gros Cap across to the Garden River Indian Reservation to the east beyond the project boundary.

Elevations of the ground surface range from approximately 650 feet (198 m) above sea level (a.s.l.) in the flat-lying areas to approximately 1250 feet (381 m) a.s.l. in the areas of exposed bedrock terrain. King Mountain, northwest of Robertson Lake in Van Koughnet Township, has the highest elevation with rugged cliffs of very steeply dipping strata reaching as high as 1880 feet (573 m) a.s.l.

Local bedrock consists of Cambrian and Precambrian rocks. The Cambrian rocks include mainly sandstone, siltstone, shale and conglomerate of the Jacobsville Formation (Russell 1982). The Precambrian rocks are of igneous, metasedimentary, and metavolcanic origin (Frarey 1977). Glacial drift is found throughout the project area. In the lowland areas drift thickness varies, but in general it is well in excess of 50 feet (15 m). In the highland areas rock outcrops are extensive and glacial drift generally forms a thin veneer. Bedrock depressions may contain deeper accumulations of glacial and modern sediments.

The surficial geology of the Sault Ste. Marie area was first studied at a regional scale by Boissonneau (1965, 1968). Further contributions dealing with the glacial history of the area have been made by Hay (1963), Prest (1970), Saarnisto (1974), Hungr and Franklin (1977), Cowan (1976, 1978, in preparation) and McQuay (1980). The following is a brief summary of the major glacial events and their related surficial materials, based on the findings of these authors.

The distribution and thickness of unconsolidated sediments, including sand and gravel, are the result of extensive glacial activity which took place during the Wisconsinan Stage of the Pleistocene Epoch. This period of time, which lasted from approximately 100 000 to 7000 years ago, was marked by the repeated advance and retreat of extensive, continental ice sheets.

Approximately 14 000 years ago the entire area of northern Ontario and parts of southern Ontario were covered by the Laurentide ice sheet, which advanced from the north-northeast. Glacial landforms and striations found on bedrock surfaces indicate that this ice sheet advanced over the Sault Ste. Marie area in a southerly direction with local deflections into the lower lying areas. The till deposited by this glacial advance is distributed throughout the project area in the form of a discontinuous bedrock-drift complex.

The discontinuous patches of till on the bedrock highlands have been derived primarily from the underlying Precambrian rock types and has been described as grey, stony to bouldery, sandy to sandy silt till, which weathers to a cohesionless pale brown to light brown bouldery fine sand. The till found in the lowland areas is a reddish brown, stony to sandy silt till which has been partly derived from the red sandstone of the underlying Jacobsville Formation. Both types of till may be suitable in places for use as select subgrade material and earth and rock fill.

The deglaciation of the Sault Ste. Marie area occurred approximately 11 000 years ago. The lack of large moraines and morainic belts within the project area and vicinity imply a continuous retreat of the main ice mass. Configuration of the regional morainic belts indicates that the ice melted back towards the north-northeast. Ice-contact deposits generally associated with stagnant ice conditions and recessional morainic features are very scarce in this area, with only two small deposits located west of Highway 17 in Fenwick Township. Gravel pits have been developed in each of these deposits with pit faces ranging from 15 to 60 feet (5 to 18 m), exposing stratified sand with pockets of coarse gravel, some till and occasional large boulders.

Meltwaters issuing from the retreating ice margin carried large quantities of sand and gravel, some of which was deposited in terraces along bedrock-controlled glacial river channels. These outwash deposits are important sources of high quality aggregate. The most significant outwash deposits are found in terraces along the upper Root River system in Aweres Township and along the early Goulais River channel in Van Koughnet Township. The deposits along the upper Root River system are generally coarse grained and cobbly and have excellent crushing potential. The aggregate along the Goulais River channel is finer grained containing very clean, sandy, fine to medium gravel, with considerably less crushable content. Subsurface data indicates that the thickness of the outwash deposits is variable ranging from 10 to 50 feet (3 to 15 m), making accurate resource estimates difficult. Numerous gravel pits have been opened in these deposits in the past to supply a full range of high quality, road-building and construction aggregates.

The outwash channels have additional geologic importance. As the glacial meltwaters flowed to lower elevations from the bedrock uplands, large accumulations of sand and gravel were deposited in a series of glaciofluvial deltas along the Gros Cap escarpment. The escarpment and these glaciofluvial deltas served as shorelines of glacial Lake Algonquin, approximately 11 000 years ago. Wave action reworked the upper surface of the glaciofluvial deltaic deposits into a sequence of glaciolacustrine beach terraces. The beach terraces represent different shoreline stages of Lake Algonquin with the highest and most pronounced situated at 1020 to 1025 feet (311 to 312 m) a.s.l.

The sand and gravel complex flanking the Gros Cap Batholith is the largest and most significant source of clean, very high quality sand and gravel in the Sault Ste. Marie area. Large quantities of sand and gravel have been extracted in the past from these deposits. The remaining reserves are still sufficient to have enabled the operation of twenty-two commercial gravel pits during 1983. Pit faces expose 20 to 100 feet (6 to 30 m) of sand and fine to coarse gravel. Pits in the lower terrace contain mostly sand with some gravel. Water well data indicate the possible presence of more coarse material at depth in these areas.

Additional lacustrine beach deposits of lesser quality generally form a veneer on irregular bedrock surfaces and are found on bedrock slopes around the Goulais River flatland and along the Goulais Bay/Lake Superior shoreline. Contamination by clay and silt, unpredictable extent and difficult access render these deposits less promising.

Other areas of the lowlands lying below 750 feet (229 m) a.s.l. consist of extensive fine to medium lacustrine sand which was deposited in nearshore shallow water. Shallow beach ridges and sand dunes near the Sault Ste. Marie Airport are common features found on top of these sand plains. These deposits contain large reserves of sand which have been extracted at a few locations in the past for the production of low-specification construction aggregate.

As glacial lake levels lowered, the sand was eroded in places to expose the underlying fine-grained deep water sediments of laminated to varved, reddish-coloured clays and silts. A good example of this erosional process is the glacial Lake Nipissing bluff which traverses the City of Sault Ste. Marie at an elevation of approximately 650 feet (198 m) a.s.l. The lacustrine clay and silt are not suitable for road-building or construction aggregate. However, the clay has been used in the past for brick manufacture and more recently as core material for a hydroelectric dam which was built within the City of Sault Ste. Marie.

The eventual draining of glacial Lake Nipissing around 4000 years ago marked the end of glacial activity in the Sault Ste. Marie area. Postglacial erosional and depositional processes have been of minor importance in modifying the physiography.

EXTRACTIVE ACTIVITY

A total of eighty-eight sand and gravel pits were identified in the Sault Ste. Marie area, including many that have been rehabilitated to other uses, are partially overgrown, or are currently inactive. The southern part of the project area, which includes the City of Sault Ste. Marie and the Corporation of the Township of Prince, has been designated since 1976 under the Pits and Quarries Control Act. Extraction of aggregate in the rest of the municipalities in the project area is administered under the Mining Act. Presently, there are twenty-two pits licenced to operate under the Pits and Quarries Control Act in the designated areas. The licenced properties have a total area of 2763.7 acres (1118.5 ha). These properties are concentrated along the Gros Cap Batholith escarpment in the large glaciolacustrine beach-glaciofluvial delta complex. Many of the properties are very large and have been extensively mined in the past to meet demand for high quality road- building and construction aggregate. The level of extractive activity is variable, depending on the number of construction projects in the area. Some operators produce large stockpiles of processed aggregate products during the summer season using por-

table crushing and screening plants. A few other pits have operating asphalt or concrete plants.

Total annual production figures from licenced pits in the designated municipalities have been compiled since 1977 by the Sault Ste. Marie District Office of the Ontario Ministry of Natural Resources. They are as follows:

Year	Production	
	Tons	Tonnes
1977	1,002,666	909 619
1978	933,601	846 963
1979	904,237	820 324
1980	1,144,313	1 038 121
1981	1,088,476	987 465
1982	708,348	642 613
1983	742,342	673 453

Future production trends are expected to equal or exceed present levels. Although sand and gravel sources are abundant in the Sault Ste. Marie area, future expansion of gravel pits is likely to be constrained by conflicting residential, economic and cultural development.

Numerous unlicenced gravel pits (pits which operate on demand under the authority of a permit) have been opened in the past in both the designated and undesignated areas to supply aggregate for local roadbuilding and construction projects. These pits are located mostly in outwash and glaciolacustrine beach deposits. During field checking, many appeared inactive, partially depleted, and some have been turned into residential development sites.

An additional source of high quality aggregate is the river bed of the St. Marys River. Sand and gravel have been extracted by dragline from this river since the 1940s by a local company. The aggregate is draglined onto barges and ferried to the shore for processing and sale. Presently, there is one licenced area in the St. Marys River south of Chene Island.

SELECTED SAND AND GRAVEL RESOURCE AREAS

Map 1 shows the deposits which contain granular materials in the Sault Ste. Marie area. The total extent of these deposits, excluding resources in the St. Marys River, is approximately 49,000 acres (19 800 ha), representing an original tonnage of 3700 million tons (3350 million tonnes). Most of these potential resources have limited value for reasons of deposit size, thickness or quality of the material. Consequently, only the most significant deposits are suggested for possible resource protection.

The selected sand and gravel deposits are shown on Map 2. The primary resource areas include gravel-filled meltwater channels which extend from Upper Island Lake through the Heyden area south to the edge of the Gros Cap Batholith escarpment, culminating in a glaciofluvial-glaciolacustrine deltaic complex in the City of Sault Ste. Marie. The deposits selected at the primary level of significance contain extremely high quality sand and gravel with deposit thicknesses ranging from 25 feet (8 m) to 80 feet (24 m) or more.

Areas of secondary significance include outwash, lacustrine beach and ice-contact deposits of generally shallower depth and smaller areal extent. These deposits are found scattered throughout the report area and ensure an alternate local aggregate source to the primary areas. Deposits included at the secondary level of significance are not the "best" sources, however, they should be considered as part of the area's aggregate supply.

In total, two large deposits have been selected at the primary level. These deposits have a combined area of 4950 acres (2000 ha), exclusive of licenced properties (Table 3). Deletions for cultural setbacks and previously extracted areas leave an estimated 2480 acres (1000 ha) currently available for extraction. Total available aggregate resources are estimated to be 320 million tons (290 million tonnes) or 9 percent of the original tonnage.

SELECTED SAND AND GRAVEL RESOURCE AREA 1

Selected Sand and Gravel Resource Area 1 lies along the Precambrian bedrock escarpment and extends from the Township of Prince boundary to Crystal Creek in the City of Sault Ste. Marie. The area includes seven segments (labelled 1a to 1g) which belong to the same deposit complex. The deposit has been subjected to surficial segmentation by creeks and streams which flow through it and drain into the St. Marys River. The resource area has been mapped as a glaciolacustrine beach-glaciolacustrine deltaic complex. Its origin is related to fluvial processes which brought sand and gravel into glacial Lake Algonquin where the material was deposited in a delta, then subsequently reworked by wave action. Other similar and parallel beach strands representing younger Algonquin, and possibly glacial Lake Nipissing shorelines, have also been noted at lower elevations. Field and subsurface data indicate that areas of high gravel content generally lie above the 850-foot (260 m) contour (Table 7, 8). Consequently, this contour was used to delineate the deposit boundary which separates the primary areas from the more sandy secondary resource areas which form the southern half of the deposit complex. Average deposit thicknesses within Area 1 have been based on the most recent pit data and subsurface information and are conservatively estimated at 35 to 80 feet (11 to 24 m).

During field checking, twenty-one licenced and eleven unlicenced pits were investigated. Most of the unlicenced pits were inactive or rehabilitated to alternate uses. Large-scale extractive activities were concentrated in the currently licenced operations. Depending on the proximity of the granitic bedrock escarpment, face heights in the pits were found to range from 20 feet (6 m) to 100 feet (30 m). From the deeper pits, gravel is extracted in 20- to 40-foot (6 to 12 m) lifts. Pit faces expose nearly horizontal to gently southward dipping, stratified, poor to well sorted, occasionally coarse and cobbly, fine to medium gravel in a matrix of fine to medium sand. The clasts are rounded to subrounded and have been derived largely from the Precambrian parent rocks of the region with some local red sandstone of the Jacobsville Formation also present in the petrographic assemblage. In the upper lifts of pits 2 to 17, typical characteristics of beach deposition such as pebble im-

brication, good stratification, and rounded clasts predominate. With depth, the material in pit faces indicates a glaciofluvial deltaic mode of deposition, displaying long, continuous, nearly horizontal topset beds with slightly higher sand content. Large topset and foreset beds were observed closer to the surface in licenced pits 18, 20 and 21, suggesting that this area was a large delta into which the meltwaters of the ancient Root River system issued during glacial Lake Algonquin time.

Because of its unique location, large extent, and large resource potential, this resource area has been the object of considerable interest in order that it would be efficiently utilized for the benefit of the local population (Cowan and Leyland 1978; Hungr and Franklin 1977; Sniezek 1976). Previous detailed testing of aggregate samples taken from the gravel pits in Area 1 by the Ontario Ministry of Transportation and Communications (M.T.C.) indicate that the average grain size composition of the aggregate is 40 to 80 percent gravel and 20 to 60 percent sand with virtually no fines. Maximum clast size is 4 to 8 inches (10 to 20 cm), with oversize boulders being very rare. Crushable content (size fraction larger than 26.5 cm) is generally well above 20 percent in most of the pits surveyed. Normally, only a secondary crusher is required to produce the desired aggregate products because of the favourable clast size ranges found throughout the deposit. Overburden is relatively uniform and thin. No more than 2 to 2.5 feet (60 to 80 cm) of overburden has to be removed in order to extract the underlying clean sand and gravel.

Detailed aggregate quality testing by M.T.C. indicates that the aggregate in Area 1 is hard and durable and generally of the highest quality (Deike 1983). The material meets the specification requirements for all M.T.C. concrete and asphalt aggregate products including Hot-Laid (H.L.) 1 surface paving course material. Hot-Laid 1 has very stringent specifications, which in southern Ontario have almost exclusively been met by crushed trap rock from the Marmora area and by the use of processed blast furnace slag. In the Sault Ste. Marie area, M.T.C. has found, through monitoring local pavement performance, that somewhat less rigid specifications are appropriate to permit the use of local coarse aggregate for H.L. 1 mixes. Thus, the use of gravel with a Petrographic Number (P.N.) up to 119 (100 in southern Ontario) and a Los Angeles Abrasion factor of about 19 to 20 percent is satisfactory for local surface paving work (Deike 1983). Petrographic numbers of tested samples for Area 1 average around 106, and Los Angeles Abrasion test percent loss is in the 16 percent range. Magnesium Sulphate Soundness Loss test results are equally low with average readings of less than 1 percent. Absorption values are also very low, averaging 0.43 to 0.69 percent.

The clean, fine to medium sand is also of high quality. The sand is often so clean that clay binder needs to be added to ensure proper compaction. Excessive quantities of sand in the gravel matrix and in separate large interbeds act as a constraint when encountered in the gravel pits, by limiting the proportion of crushable gravel available.

The excellent quality and market potential of the gravel from Area 1 has long been recognized and has resulted in extensive extraction within the presently licenced properties and in some of the rehabilitated pits. Although large reserves of sand and gravel still remain, constraints such as depth to groundwater table, extent of bedrock protrusion into the deposit, housing, and other developments will need to be given careful consideration, as the deposit is mined.

Selected Resource Area 1 occupies 2650 acres (1080 ha), exclusive of licenced properties. Allowances for cultural setbacks and previously extracted areas leave 1820 acres (730 ha) currently available for development. Assuming deposit thicknesses of 35 to 80 feet (11 to 24 m), sand and gravel resources are estimated to be 275 million tons (249 million tonnes). The resource area is easily accessible and ideally located to serve the area's markets.

SELECTED SAND AND GRAVEL RESOURCE AREA 2

Selected Sand and Gravel Resource Area 2 is located along Highways 17 and 556 in the City of Sault Ste. Marie and Aweres Township. The deposits consist of coarse sand and coarse cobbly and bouldery gravel which were deposited in terraces by fast flowing meltwaters along bedrock controlled valleys in the upper Root River system. This river system was also a feeder channel carrying the finer sand and gravel into the deposit which forms Selected Resource Area 1.

Thirteen gravel pits have been noted in Area 2 (pits 49 to 60 and 63). Many of them were found inactive or are now used as housing sites. Pit faces indicate 5 to 60 feet (1.5 to 18 m) of poorly to moderately sorted, medium to coarse sand and gravel with abundant quantities of subangular to rounded cobbles and boulders. Maximum clast sizes are 4 to 18 inches (10 to 46 cm). Grain size analysis of aggregate samples from these deposits indicate that gravel content varies between 15 and 80 percent.

The surface of Area 2 is generally flat, and the estimation of deposit thickness was difficult because of the variable surface of the underlying bedrock. In the Heyden area, geophysics work was used to supplement water well data to obtain additional depth estimates of the deposit (SSM-GT-1 to 4, Table 8). Although water wells indicate a wide range of gravel thickness, in places reaching 65 feet (20 m), a conservative estimate of 25 feet (8 m) was used as an average deposit thickness for resource tonnage calculations. This resource estimate accounts for the depth of the groundwater table which may also limit extraction. Removal of overburden does not pose a problem.

Aggregate quality and suitability testing has been carried out by M.T.C. on aggregate samples collected from these deposits in the past and during field checking. Test results indicate that the aggregate is hard, durable, and of very high quality. The most common rock types occurring in the petrographic assemblage include granite, diorite, gabbro, greywacke, volcanics, gneiss, schist and smaller percentages of quartzite and trap rock. Petrographic numbers range from 103 to 112. Los Angeles Abrasion and Magnesium Sulphate Soundness losses range from 15 to 17 and 0.4 to 2.3 percent, respectively. Absorption gains are negligible. These test results imply that the aggregate, with appropriate processing, would meet the suitability r

quirements for the full range of M.T.C. aggregate products including H.L. 1 surfacing aggregate.

Extraction may be somewhat affected by the presence of cobbles and boulders, often in high percentages, which necessitate the use of a primary crusher to reduce the clasts to a suitable size for processing. The sand in these deposits is also of high quality, although tending to be coarser than the sand found in the beach deposits. Factors limiting sand quality, if encountered, are likely to be excessive coarseness and occasional dirty sections, both requiring sand control.

Selected Resource Area 2 occupies 2270 acres (920 ha). Many parts of the deposit have been sterilized by residential and commercial development. Setback allowances and cultural constraints, therefore, reduce the available area to 660 acres (265 ha). Assuming an average deposit thickness of 25 feet (8 m), available resources are approximately 42 million tons (38 million tonnes). Highways 17 and 556 traverse the resource area providing efficient transportation routes to local destinations.

SAND AND GRAVEL RESOURCE AREAS OF SECONDARY SIGNIFICANCE

Several sand and gravel deposits scattered throughout the Sault Ste. Marie area have been selected as Sand and Gravel Resource Areas of Secondary Significance. They include lacustrine beach, ice- contact and outwash deposits. These deposits are likely to contain large quantities of sand with lesser quantities of crushable gravel.

The largest beach deposit included in this group is the southern part of the large glaciolacustrine beach-glaciolacustrine delta complex, which traverses the City of Sault Ste. Marie and forms Selected Resource Area 1. Gravel pits, water well data and test holes (Table 7) indicate that the deposit consists of fine to medium sand with minor quantities of crushable gravel in the northeastern part of the deposit. Deposit thickness is variable, ranging from 50 to 200 feet (15 to 61 m) in places. Much of the deposit has been built over, limiting remaining extractive potential to the Crystal Creek area at the east end of the deposit. Records obtained from M.T.C. indicate that the sand has been used in the past for low- specification road construction aggregate such as select subgrade material and Granular Base Course (G.B.C) B and C. Lack of binder for proper compaction and fineness of gradation are the major quality limitations.

Other glaciolacustrine beach deposits representing shorelines of Lake Algonquin have also been included at the secondary level. These deposits are much smaller than the one in the City of Sault Ste. Marie and are different in a number of aspects. All of these deposits are beach terraces which have been developed by wave action on bedrock surfaces at topographically suitable locations.

Field investigation of the beach deposits in Kars Township indicates that they are 5 to 10 feet (1.5 to 3 m) deep and are often contaminated by lenses of reddish-coloured silt and clay. A sample taken from pit 23 indicated 23 percent gravel, 76 percent sand and 1 percent fines (Figure 2a). A P.N. of 252 makes the material suitable only for low-specification uses. Small pits in these deposits are locally important, because they supply aggregate for cottage construction and septic tank bedding.

A beach deposit located near the Lake Superior shoreline in Pennefather Township was also investigated. Two small pits (43 and 44) were examined. In pit 44, a 10- to 20-foot (3 to 6 m) face showed rounded fine to coarse gravel in a coarse sand matrix. Laboratory analysis of the sample taken from this location indicated 58 percent gravel and 42 percent sand (Figure 2a). A P.N. of 104 suggests that the aggregate is hard and sound. Bedrock underlying the deposit is exposed in the pit. Limited quantities of good quality aggregate may be present in other bedrock depressions within the deposit. Average deposit thickness appears to be 10 to 15 feet (3 to 5 m). A seasonal cottage road provides access to the deposit.

Two ice-contact stratified drift deposits, resembling kames, have been included at the secondary level of significance. Both are located in Fenwick Township along Highway 17. Three pits (27, 30 and 31) have been opened in these deposits. In pit 27, faces expose 40 to 60 feet (12 to 18 m) of stratified medium to coarse sand with pockets of angular to subrounded fine to coarse gravel. Pit 31 indicates a more typical ice-contact type of depositional environment. A 40- to 60-foot (12 to 18 m), slightly slumped face is predominantly sand with irregular pockets of fine to coarse gravel. Till-like material consisting of angular cobbles, boulders and coarse gravel-sized clasts in a red clay matrix is also exposed in one section of the pit. Large boulders 2 to 4 feet (0.6 to 1.2 m) in diameter, clay- and silt-coated clasts and micro faulting are also evident. Data obtained from M.T.C. indicate that, despite some of the quality limitations, the possible uses for the aggregate from these pits have included select subgrade material, G.B.C. A, B and C, H.L. 4 and 8 stone and 16 mm Type A and B crushed stone. Because of the highly variable nature of ice-contact deposits, further detailed investigations would be required to fully determine the remaining reserve potential of these deposits.

Numerous small outwash deposits have also been included at the secondary significance level. Two of them are located on the bedrock highland along Red Rock Road in the northwestern corner of the City of Sault Ste. Marie. The geological setting of the area suggests that these deposits were laid down by meltwaters of early Bennett Creek and its tributaries. A small exposure on the roadside indicates poorly sorted, faintly stratified, rounded to subrounded, cobbly, fine to coarse gravel in a fine to medium sand matrix. Grain size and petrographic analyses indicate 42 percent gravel, 57 percent sand, 1 percent fines and a P.N. of 140. The aggregate is clean and of relatively good quality. However, irregular deposit thickness and groundwater may limit the amount of available aggregate. These deposits may be able to supply material for local road-maintenance and cottage developments.

Other outwash deposits are located in Van Koughnet Township. The origin of these deposits is associated with the early Goulais River meltwater channel system. Deposits of gravel are found in the bedrock highland area near the township's eastern boundary, whereas deposits of fine gravel and sand are found in the lowland area along the present-day banks of the Goulais River. The segregation of coarser

and finer aggregates in this fashion is characteristic of fluvial systems when there is a change in the flow rate of the system. As the early Goulais River reached the lowland area, its flow rate slowed and, therefore, was only able to carry finer-grained sediments. Gravel content varies from 15 to 60 percent in the gravel deposits of the highland areas (pit 34).

Pit 33 is located in the sandy outwash material in the lowland area. Pit faces here expose 10 to 15 feet (3 to 5 m) of horizontally bedded, medium to coarse sand with some fine to medium gravel and occasional thin layers of coarse gravel. Crossbedding and cut-and- fill stratification suggest a braided stream type of depositional environment. A sample taken and analyzed from this location showed 20 percent gravel, 78 percent sand and 2 percent fines (Figure 3a). The sand tends to be much coarser than the sand in the beach deposits.

A summary of aggregate quality test data (Deike 1983) indicates that the outwash material in Van Koughnet Township has a slightly higher Petrographic Number, Los Angeles Abrasion and Magnesium Sulphate percentage losses than the aggregate in Selected Resource Areas 1 and 2.

Although they are of somewhat lower quality than the resource areas in and near the City of Sault Ste. Marie, secondary areas are capable of satisfying part of the demand for aggregate. These deposits should be considered as part of the total aggregate supply.

SAND AND GRAVEL RESOURCE AREAS OF TERTIARY SIGNIFICANCE

Numerous lacustrine beach and lacustrine plain sand deposits have been included at the tertiary level of significance. The largest deposits include the beach terraces of glacial Lake Algonquin located above the Lake Superior shoreline in Dennis Township and the areas draping the bedrock slopes around the Goulais River lowland. These deposits have been found to contain sporadic patches of clay- and silt-contaminated beach sand with some gravel. Access to these deposits is very difficult beyond the few old logging roads. The sand and gravel was deposited in bedrock depressions. The deposits are often discontinuous and difficult to access and investigate with power equipment. Other lacustrine sand and gravel deposits in the lowland areas have large reserves of fine sand. However, fineness of gradation, excessive fines content and swampy conditions considerably limit their potential for extraction.

In light of the abundance of many large and high quality aggregate deposits in the Sault Ste. Marie Area, deposits included at the tertiary level are not considered an important part of the project area's aggregate supply.

ALTERNATE SOURCES OF SAND AND GRAVEL

In addition to its role as a vital shipping corridor, the St. Marys River is also a source of high quality aggregate. A large deposit located southwest of Chene Island has been mined by dragline since the 1940s for sand and gravel. Because of the presently abundant surficial sand and gravel deposits, this deposit has not been investigated in detail to date. As the land-based aggregate sources gradually diminish, this alternative would deserve attention. Limited information suggests that the deposit is 3 to 25 feet (1 to 8 m) thick and that the actual areal extent of the deposit is much larger than the presently licenced 1400.5 acres (566.8 ha) (I. Valentine, Lands/Parks Supervisor, Ontario Ministry of Natural Resources, Sault Ste. Marie, personal communication, 1983).

Algoma Steel Corporation Ltd. produces huge quantities of blast furnace slag, which is stockpiled near the steel works. Although normally considered as a waste product, blast furnace slag with proper treatment and processing can be used as an aggregate material. Application possibilities for pelletized blast furnace slag include: lightweight aggregate in structural concrete, aggregate in block manufacturing, slag cement manufacture, road sub-base and autoclaved bricks and blocks. Algoma Steel slag is marketed by one local company and used mainly for making driveway pavement.

BEDROCK GEOLOGY

The bedrock of the Sault Ste. Marie area is made up of a complex variety of rock units ranging in age from Precambrian to Cambrian. The Precambrian rocks represent both the Superior and Southern Structural Provinces of the Canadian Shield. Hay (1963, 1964), Bennett et al. (1975), Frarey (1977), Springer (1977), Giblin and Leahy (1976, 1979), Leahy and Giblin (1979) and Russell (1982) have given detailed descriptions of the geology, mineral potential and areal extent (see Map 3) of these rocks within the project area. The following discussion is based on the works of these authors.

The oldest rocks (Rock Unit K) are Archean mafic to intermediate metavolcanics and metasediments which are estimated to have been formed more than 2600 million years ago. These rocks underlie small portions of Fenwick and Van Koughnet Townships and have been mapped as unsubdivided units of mafic to intermediate volcanic flows and minor interflow metasediments. They are schistose or gneissic, indicating that they have undergone extensive deformation. Rocks of Unit K have not been selected for bedrock resource protection.

Rock Unit J, which includes felsic intrusive and metamorphic rocks also Archean in age, is the most extensive rock unit in the project area and is commonly referred to as the Gros Cap Batholith. It consists of massive granitic and foliated migmatitic rocks with migmatite being most common. Based on mineral composition and massive appearance in the field, the granitic rocks of Unit J may be suitable for extractive development. If future analysis indicates that they do not cause excessive wear on processing equipment, crushed stone production may be economically possible. Unit J is not quarried for aggregates in this area and it has not been recommended for resource protection because of the abundance of high quality, more cost effective surficial aggregate deposits located along the south face and on top of the Gros Cap Batholith.

Proterozoic rocks of the Huronian Supergroup (Rock Units E to I) underlie the eastern portions of Aweres and Van Koughnet Townships and have been

described as a thick sequence of detrital sedimentary rocks which have been deposited on the eroded Archean basement from approximately 2500 million to 2150 million years ago. These rocks range in composition from quartzites, arkoses, conglomerates, limestones, greywackes to calcareous siltstones. After deposition, the Huronian sequence of rocks was subjected to folding and metamorphism. Because of extensive mineral and structural alterations, certain varieties of these rock types may weather easily, while others may be alkali-silica reactive. For example, greywackes and argillites may contain coarse-grained quartz with a deformed crystal lattice. This type of quartz is an alkali-silica reactive mineral, meaning that the quartz is likely to react with alkalis from the cement paste and may cause expansion and cracking of concrete (Rogers 1979). This characteristic may restrict the suitability of these rocks to road construction applications only. Certain types of the Huronian sequence rocks have been found excessively hard for economic quarrying purposes elsewhere (Ontario Geological Survey 1984). There is no previous history of bedrock quarrying activities for road-building and construction aggregate from these rocks within the Sault Ste. Marie area. These rock units have not been selected for bedrock resource protection.

After deposition of the rocks of the Huronian Supergroup the Nipissing intrusive rocks were emplaced. They are shown on the accompanying map as Unit D and consist of diabase, gabbro and granophyre. They form erosion-resistant ridges and scarps in the vicinity of Robertson Lake in Van Koughnet Township and may be suitable for extractive development. The rocks do not contain olivine. Olivine is a mineral which largely contributes to weathering and breakdown in construction materials. Detailed petrographic data is lacking for this rock unit and there has been no history of extractive activity. Based solely on geological description, Rock Unit D may be suitable for production of road- building and construction aggregate after segments of appropriate hardness and petrographic quality have been identified.

Middle Proterozoic rocks of the Keweenawan (Units B and C) underlie only relatively small sectors of the study area and consist of felsite, quartz-feldspar porphyry and basalt. These units and Unit D, although not selected for resource protection at this time, may become significant in the future when the surficial aggregate deposits of the Sault Ste. Marie area become depleted.

The youngest bedrock unit of the area is the Cambrian Jacobsville Formation (Rock Unit A). It underlies much of the lowland portions of the Sault Ste. Marie area and consists mostly of flat-lying red sandstone with lesser amounts of siltstone, shale and conglomerate. Glacial sediments often in excess of 50 feet (15 m) cover the Jacobsville Formation. However, at a few thinly drift covered locations, especially near the Lake Superior shoreline in Dennis and Kars Townships, exposures of the red sandstone bedrock are present. At the time of field work, there was one small licenced quarry along the bank of the Root River within the City of Sault Ste. Marie. Limited quantities of red- to buff-coloured arkosic sandstone are extracted from a 7-foot (2 m) face for use as decorative facing stone. The Jacobsville Formation sandstone is not suitable for use as load-bearing and construction aggregate because it is weak and porous and weathers to sand. It has been, however, a traditional source of building and decorating stone in areas where it outcrops and more recently it was used as compacted fill on the Great Lakes Power Development Project. This bedrock unit has not been selected as a bedrock resource area.

There is future potential for extraction of bedrock for road- building and construction aggregate in the Sault Ste. Marie area when the high quality glacial deposits of sand and gravel become depleted, thereby forcing local aggregate producers to turn to the more expensive alternative of bedrock quarrying. At that time, detailed investigations will be required to delineate specific areas in these rock units which would be suitable for quarrying.

SUMMARY

The sand and gravel deposits of the Sault Ste. Marie area are the product of glacial processes which took place during the Wisconsinan Stage of the Pleistocene Epoch. The most important aggregate-bearing deposits found in this area include glaciolacustrine beach terraces, outwash and ice-contact deposits. The largest deposit, containing the best quality aggregate, is the glaciofluvial-glaciolacustrine deltaic complex flanking the Gros Cap escarpment in the City of Sault Ste. Marie.

The Sault Ste. Marie area has significant resources of high quality sand and gravel suitable for a wide range of road-building and construction aggregate. The remaining aggregate reserves should be sufficient to meet local needs for a considerable period of time. Several deposits have been selected for possible resource protection at the primary and secondary levels. Continuing careful management will be required to preserve as much of the resources as possible. Future considerations may include draglining the St. Marys River and using locally produced blast furnace slag as alternate sources of aggregate.

The bedrock of the Sault Ste. Marie area consists of Cambrian and Precambrian rocks. The Cambrian sandstone of the Jacobsville Formation is not suitable for use as road-building aggregate, but it has good potential for decorative stone applications. The Precambrian rocks of the bedrock highlands include a wide variety of complex rock types, with some having future potential for crushed stone development. More detailed investigation will be required to delineate potential extraction sites.

Enquiries regarding the Aggregate Resources Inventory of the Sault Ste. Marie area should be directed to the Ontario Ministry of Natural Resources either at the Sault Ste. Marie District Office, 875 Queen Street East, Sault Ste. Marie, Ontario, P6A 5L5 (Tel. (705) 949-1231) or at the Northeastern Region Office, 199 Larch Street, Sudbury, Ontario, P3E 5P9 (Tel. (705) 675-4120).

TABLE 1. TOTAL SAND AND GRAVEL RESOURCES, SAULT STE. MARIE AREA.

1 Class No.	2 Deposit Type (see Appendix C)	3 Areal Extent Acres (Hectares)	4 Original Tonnage Millions of Tons (Tonnes)
City of Sault Ste. Marie			
1	G-LB	211 (85)	37 (34)
	S-LB	3300 (1340)	800 (730)
	G-LB-LD	2950 (1190)	450 (410)
	S-LP	10,700 (4350)	1100 (1000)
	G-OW	96 (39)	6 (5)
	G-OW-LD	600 (243)	107 (97)
2	S-LB	101 (41)	4 (4)
	S-LP	1000 (405)	38 (34)
	G-OW	420 (170)	16 (14)
	S-OW	223 (90)	8 (7)
3	S-LB	42 (17)	<1 (<1)
	S-LP	53 (21)	1 (1)
	S-OW	147 (60)	3 (3)
	S-WD-LP	1880 (760)	38 (34)
4	S-LP	1230 (500)	12 (11)
		23,000 (9300)	2600 (2360)
Corporation of the Township of Prince			
1	S-LB	495 (200)	72 (65)
	G-LB-LD	84 (34)	10 (9)
	S-LP	325 (132)	41 (37)
2	G-LB	60 (24)	2 (2)
	S-LP	104 (42)	4 (4)
	G-OW	52 (21)	2 (2)
	S-OW	250 (101)	9 (8)
3	S-LB	1110 (450)	22 (20)
	S-LP	445 (180)	9 (8)
	G-OW	84 (34)	2 (2)
	S-WD-LP	270 (109)	5 (4)
		3300 (1340)	178 (162)
Kars Township			
1	S-LP	90 (36)	5 (4)
2	S-LP	1770 (720)	66 (60)
3	G-LB	1510 (610)	30 (27)
	S-LB	159 (64)	3 (3)
4	S-LB	435 (176)	4 (4)
	S-LP	340 (138)	3 (3)
		4300 (1740)	111 (101)
Fenwick Township			
1	S-LB	88 (36)	11 (10)
	S-LP	2090 (850)	192 (174)
	S-IC	199 (81)	31 (28)
3	G-LB	159 (64)	3 (3)
	S-LB	36 (15)	1 (1)
4	S-LB	630 (255)	6 (5)
	S-LP	375 (152)	4 (4)
		3600 (1460)	247 (224)
Van Koughnet Township			
1	S-LB-LP	1170 (475)	59 (54)
	S-LP	960 (390)	90 (82)

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 1. TOTAL SAND AND GRAVEL RESOURCES, SAULT STE. MARIE AREA.

1 Class No.	2 Deposit Type (see Appendix C)	3 Areal Extent Acres (Hectares)	4 Original Tonnage Millions of Tons (Tonnes)
2	G-LB	315 (128)	12 (11)
	S-LB-LP	231 (94)	9 (8)
	S-LP	92 (37)	4 (4)
3	S-LB	715 (290)	14 (13)
	S-OW	22 (9)	<1 (<1)
		5300 (2140)	255 (231)
Dennis Township			
1	S-LP	265 (107)	13 (12)
3	G-LB	36 (15)	<1 (<1)
	S-LB	3100 (1260)	62 (56)
		3400 (1380)	75 (68)
Pennefather Township			
2	G-LB	310 (126)	12 (11)
3	G-LB	84 (34)	2 (2)
	S-LB	1690 (680)	34 (31)
	S-OW	320 (130)	7 (6)
4	S-LB	48 (19)	<1 (<1)
	S-OW	32 (13)	<1 (<1)
		2480 (1000)	55 (50)
Aweres Township			
1	G-OW	2180 (880)	137 (124)
3	S-LB	1330 (540)	27 (24)
	G-OW	92 (37)	2 (2)
	S-OW	100 (40)	2 (2)
		3700 (1500)	168 (152)
		49,000 (19 800)	3700 (3350)

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 2a. SAND AND GRAVEL PITS (DESIGNATED AREAS), SAULT STE. MARIE AREA.

1 No.	2 MTC No.	3 Owner/ Operator	4 Location	5 Licenced Areas Acres (Hectares)	6 Face Height Feet (Metres)	7 % Gravel
City of Sault Ste. Marie						
LICENCED PITS						
1	-	A.B. McLean Ltd.	Chene Island Area	1400.5 (566.8)	N/A (dragline operation)	20-80 variable
3	S10-028	City of Sault Ste. Marie	E 1/2 of E 1/2 of NE 1/4, Section 19	40.0 (16.2)	20-40 (6-12)	60-80
4	-	Mr. Borden Avery	SW 1/4 of NW 1/4, Section 20	41.7 (16.9)	20-40 (6-12)	60-80
5	S10-031	Mr. Peter Ironside, Mr. Joseph Wierzbicki	E 1/2 & NW 1/4 of NW 1/4, Section 20	120.0 (48.6)	20-40 (6-12)	60-80
6	S10-029	Mr. Lloyd G. Avery	N 1/2 of SW 1/4, Section 16	14.0 (5.7)	40-60 (12-18) 20-40 (6-12)	60-80 20
7	-	A.B. McLean Ltd.	W 1/2 of E1/2, Section 16	49 4 (20.0)	40-60 (12-18)	60-80
8	-	Mr. Howard Avery	Pt. W 1/2 of E 1/2 of E 1/2, Section 16	21.8 (8.8)	20-40 (6-12)	60-80
9	-	Mr. Howard Avery	Pt. W 1/2 of NE 1/4 of NE 1/4, Section 21	12.9 (5.2)	30-50 (9-15)	10
10	S10-056, 030	Mr. Robert McQueen	Pts. of NW 1/4 & SW 1/4 of SW 1/4, Section 14	33.9 (13.7)	(N.pt.) 60-80 (18-24) (S.pt.) 70-100 (21-30)	60-80 10
11	S10-074	Robinson Construction Ltd.	NW 1/4 of NW 1/4, Section 13	40.0 (16.2)	20-30 (6-9)	60-80 partially overgrown
12	S10-075	City of Sault Ste. Marie	Pt. SW 1/4 &Pt. NW 1/4 of SE 1/4, Section 12	65.0 (26.3)	20-30 (6-9)	40-60 inactive, partially overgrown
13	S10-077	Condor Sand & Gravel	NW 1/4 of NE 1/4, Section 13	40.0 (16.2)	80-100 (24-30)	20-40
14	S10-045	Towland-Hewitson Construction	Pt. SE 1/4, Section 12	65.0 (26.3)	80-100 (24-30)	60-80

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 2a. SAND AND GRAVEL PITS (DESIGNATED AREAS), SAULT STE. MARIE AREA.

1 No.	2 MTC No.	3 Owner/ Operator	4 Location	5 Licenced Areas Acres (Hectares)	6 Face Height Feet (Metres)	7 % Gravel
15	S10-039	Cor-Mar Enterprises Ltd.	Pt. Section 13 being Parcel 3892	13.0 (5.3)	80-100 (24-30)	60-80
16	S10-040	Gerald D. Hill, Algo Contracting Co. Ltd.	Pt. SW 1/4 of SW 1/4, & Pt. NW 1/4 of SW 1/4, Section 7	50.7 (20.5)	80-100 (24-30)	60-80
17 &18	S10-093, -042	City of Sault Ste. Marie	NE 1/4 of SW 1/4, Section 7, N 1/2 of SW 1/4 & W 1/2 of SE 1/4 of NE 1/4, Section 7	180.3 (73.0)	40-100 (12-30)	60-80 landfill
19	-	Cherokee Construction & Disposal Company Ltd.	E 1/2 of SE 1/4 of NE 1/4, Section 7; N 1/2 of SE 1/4, Section 7	97.9 (39.6)	40-100 (12-30)	60-80 landfill
20	S10-090, -043, -047	Brandes Construction Ltd.	S 1/2 of SW 1/4 & W 1/2 of SW 1/4 of SE 1/4, Section 5; Pt. NW 1/4 & Pt. NE 1/4, Section 8	324.7 (131.4)	40-50 (12-15)	60-80
21	S10-078	Elwood Robinson Ltd.	NE 1/4 of NE 1/4, Section 8	40.0 (16.2)	35-40 (11-12)	60-80
22	S10-079	Norman, Mary and Kenneth Scott	S 1/2 of SE 1/4, Section 10	80.0 (32.4)	-	- unopened
				2730.8 (1105.2)		

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 2a. SAND AND GRAVEL PITS (DESIGNATED AREAS), SAULT STE. MARIE AREA.

1 No.	2 MTC No.	3 Owner/ Operator	4 Location	5 Licenced Areas Acres (Hectares)	6 Face Height Feet (Metres)	7 % Gravel
UNLICENCED PITS*						
67	S10-060	Mrs. E. Woods	SW 1/4, Section 19		15-70 (5-21)	- rehabilitated
68	S10-061	J. Taraniuk	SW 1/4, Section 19		35-45 (11-14)	40 rehabilitated
69	S10-064	O. Reed	SE 1/4, Section 19		5-15 (1.5-5)	10
70	S10-073	B. Avery	SE 1/4, Section 19		40-60 (12-18)	0-10 overgrown
71	S10-055	R.M.S. Building Supply	NE 1/4, Section 20		25 (8)	10 partially rehabilitated
72	S10-054	Avery	SW 1/4, Section 16		30-60 (9-18)	60-80 partially rehabilitated
73	S10-033	Gartshore	NE 1/4, Section 14		10-20 (3-6)	variable, inactive, overgrown
74	S10-032	Algoma Steel	SW 1/4, Section 13		20-25 (6-8)	0
75	S10-072	Maki Farm	NW 1/4, Section 24		10 (3)	0 inactive
76	S10-035	E. Robinson	SW 1/4, Section 20		10-20 (3-6)	50 depleted
77	S10-034	W. Young	NW 1/4, Section 13		30-50 (9-15)	10-30
78	S10-037	D. Smith	NE 1/4, Section 13		60-80 (18-24)	20-40 higher in pockets
79	S10-044	Coswell Superior Iron	NE 1/4, Section 8		10-15 (3-5)	55 overgrown
80	S10-046	Mrs. C. Smith	SW 1/4, Section 8		15-30 (5-9)	20-40
81	S10-048	Central & Hudson Bay Railway	NW 1/4, Section 9		-	60-80 rehabilitated
82	S10-049	Alex McLean	NE 1/4, Section 16		40-50 (12-15)	30-40
83	S10-094	Scott	SE 1/4, Section 10		20-30 (6-9)	40-60 nearly depleted
84	S10-057	T. Irwin	NE 1/4, Section 16		20-30 (6-9)	20-40

N.B. Minor variations in all tables are caused by rounding of data.

*Abandoned pits or wayside pits operating on demand under authority of a permit.

TABLE 2a. SAND AND GRAVEL PITS (DESIGNATED AREAS), SAULT STE. MARIE AREA.

1 No.	2 MTC No.	3 Owner/ Operator	4 Location	5 Licenced Areas Acres (Hectares)	6 Face Height Feet (Metres)	7 % Gravel
85	S10-062	P. Denys	NE 1/4, Section 10		5-10 (1.5-3)	sand rehabilitated
86	S10-038	Algoma Steel	NW 1/4, Section 3		-	- slag heap
87	S10-051	A.B. McLean	-		-	- rehabilitated
88	S10-066	Hope, Kennis & Butler	-		0-6 (0-2)	sand rehabilitated
Corporation of the Township of Prince						
LICENCED PITS						
2	-	Avery & Onraet Ltd.	Pt. W 1/2 of NW 1/4, Section 25	32.9 (13.3)	30-100 (9-30)	20-40
				32.9 (13.3)		
UNLICENCED PITS*						
64	I03-001	Unknown	NW 1/4, Section 32		50 (15)	0 overgrown
65	S10-058	Avery & Onraet, Sharp	SW 1/4, Section 25		50-80 (15-24)	25-35 inactive
66	S10-059	Holbrook	NE 1/4, Section 25		50-80 (15-24)	25-35 inactive

N.B. Minor variations in all tables are caused by rounding of data.

*Abandoned pits or wayside pits operating on demand under authority of a permit.

TABLE 2b. SAND AND GRAVEL PITS (UNDESIGNATED AREAS), SAULT STE. MARIE AREA.

1 No.	2 MTC No.	3 Owner/ Operator	4 Location	5 Face Height Feet (Metres)	6 % Gravel	7 Pit Status
Kars Township						
23	-	Unknown	NW 1/4, Section 10	4-8 (1.2-2)	20-40	partially depleted
24	-	Unknown	W 1/2, Section 14	4-6 (1.2-2)	40	rehabilitated (now a landfill)
Fenwick Township						
25	-	Unknown	SW 1/4, Section 8	40-60 (12-18)	0-5	active
26	S28-025	S. Storozuk	NE 1/4, Section 1	5-10 (1.5-3)	0-20	partially overgrown
27	S28-007	Yourchuk	SW 1/4, Section 1	40-60 (12-18)	20-30	active
28	S28-024	K. Peirman	SE 1/4, Section 1	10-30 (3-9)	-	overgrown, depleted, inactive
30	S10-001	James	SE 1/4, Section 13	15 (5)	30	rehabilitated
31	S10-002	Nardi & M.T.C.	NE 1/4, Section 24	40-60 (12-18)	20-30	inactive, partially overgrown
Van Koughnet Township						
29	S28-008	Feifel	SE 1/4, Section 18	10 (3)	-	overgrown, inactive
32	S10-003	L. Zenzen	NE 1/4, Section 30	5-10 (1.5-3)	20-35	inactive, overgrown
33	S10-005	M.T.C.	NE 1/4, Section 33	10-15 (3-5)	20	inactive
34	S10-017	M.T.C.	E 1/2, Section 36	15 (5)	15-60	inactive
35	S10-004	N. Elliot	SW 1/4, Section 31	5-15 (1.5-5)	0-5	rehabilitated
36	S10-006	Olier	NW 1/4, Section 39	15 (5)	0	depleted, rehabilitated
37	S10-088	M.T.C.	NE 1/4, Section 37	10-20 (3-6)	40-60	inactive
38	S10-007	Unknown	SW 1/4, Section 39	15 (5)	-	depleted, rehabilitated
39	S10-009	Edith B. Legge	SE 1/4, Section 37	5-15 (1.5-5)	15-80	inactive
40	S10-084	M.T.C.	SE 1/4, Section 37	10-15 (3-5)	10-20	inactive
41	S10-008	Unknown	SW 1/4, Section 39	20 (6)	0	depleted
Dennis Township						
42	-	Unknown	NW 1/4, Section 4	4-6 (1.2-2)	60-80	depleted, inactive

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 2b. SAND AND GRAVEL PITS (UNDESIGNATED AREAS), SAULT STE. MARIE AREA.

1 No.	2 MTC No.	3 Owner/ Operator	4 Location	5 Face Height Feet (Metres)	6 % Gravel	7 Pit Status
Pennefather Township						
43	-	Unknown	NW 1/4, Section 9	10-20 (3-6)	60-80	inactive
44	-	Unknown	SW 1/4, Section 9	10-20 (3-6)	60-80	depleted
Aweres Township						
45	S10-013	Unknown	W 1/2, Section 6	10 (3)	0-10	overgrown
46	S10-012	Unknown	W 1/2, Section 6	5-10 (1.5-3)	0	overgrown
47	S10-024	Crown	NW 1/4, Section 3	5-8 (1.5-2)	25-40	overgrown
48	S10-025	Unknown	NW 1/4, Section 3	0-6 (0-2)	0	overgrown
49	S10-014	Heyden Heights	SE 1/4, Section 7	20-30 (6-9)	60-80	partially overgrown
50	S10-016	Crown	NE 1/4, Section 18	25-35 (8-11)	60-80	active
51	S10-027	Y.M.C.A.	SE 1/4, Section 10	25-60 (8-18)	35-70	rehabilitated
52	S10-026	Y.M.C.A.	SE 1/4, Section 10	25 (8)	35-70	rehabilitated
53	S10-023	M.T.C.	SW 1/4, Section 10	10-20 (3-6)	20-40	rehabilitated
54	S10-052	M.T.C.	NE 1/4, Section 16	20-30 (6-9)	20-40	inactive
55	S10-018	Rupert Price Wilson Estate	NE 1/4, Section 20	15-25 (5-8)	60-70	inactive
56	S10-063	Heyden Heights Developments	NE 1/4, Section 20	10-20 (3-6)	60	rehabilitated
57	S10-022	Lakeway Real Estate	NW 1/4, Section 28	-	40-70	rehabilitated
58	S10-089	M.T.C.	NE 1/4, Section 28	-	15-25	rehabilitated
59	S10-019	Harrison Construction	SE 1/4, Section 29	5-15 (1.5-5)	60-80	inactive
60	S10-081	M.T.C.	SE 1/4, Section 29	-	50	overgrown
61	-	Unknown	NW 1/4, Section 32	10-15 (3-5)	30-40	active
62	-	Unknown	NW 1/4, Section 34	4-7 (1.2-2)	20-30	depleted, inactive
63	S10-020	MacIntyre	NE 1/4, Section 32	15 (5)	30-80	overgrown

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 3. SELECTED SAND AND GRAVEL RESOURCE AREAS, SAULT STE. MARIE AREA.

1 Deposit No.	2 Unlicenced Area Acres (Hectares)	3 Cultural Setbacks Acres (Hectares)	4 Extracted Area Acres (Hectares)	5 Available Area Acres (Hectares)	6 Estimated Deposit Thickness Feet (Metres)	7 Available Aggregate Millions of Tons (Tonnes)
City of Sault Ste. Marie						
1a	250	80	5	168	70	29
	(101)	(32)	(2)	(68)	(21)	(26)
1b	1150	330	10	810	80	162
	(465)	(134)	(4)	(330)	(24)	(147)
1c	710	210	5	495	40	50
	(285)	(85)	(2)	(200)	(12)	(45)
1d	188	50	10	128	35	11
	(76)	(20)	(4)	(52)	(11)	(10)
1f	260	105	0	155	40	16
	(105)	(42)	(0)	(63)	(12)	(14)
1g	20	10	5	5	40	1
	(8)	(4)	(2)	(2)	(12)	(1)
	2600	780	35	1760		269
	(1050)	(315)	(14)	(710)		(244)
2	96	40	0	56	25	4
	(39)	(16)	(0)	(23)	(8)	(4)
	2700	820	35	1820		273
	(1090)	(330)	(14)	(740)		(248)
Corporation of the Township of Prince						
1d	44	5	5	34	35	3
	(18)	(2)	(2)	(14)	(11)	(3)
1e	21	0	0	21	65	3
	(8)	(0)	(0)	(8)	(20)	(3)
	65	5	5	55		6
	(26)	(2)	(2)	(22)		(5)
Aweres Township						
2	2170	1540	30	600	25	38
	(880)	(620)	(12)	(243)	(8)	(34)
	4950	2360	70	2480		320
	(2000)	(960)	(28)	(1000)		(290)

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 4. TOTAL IDENTIFIED BEDROCK RESOURCES, SAULT STE. MARIE AREA

1 **DRIFT THICKNESS** Feet (Metres)	2 **FORMATION**	3 **ESTIMATED DEPOSIT THICKNESS** Feet (Metres)	4 **AREAL EXTENT** Acres (Hectares)	5 **ORIGINAL TONNAGE** Millions of Tons (Tonnes)
City of Sault Ste. Marie				
0-3	Bedrock	60	78	15
(0-1)	Unit A	(18)	(32)	(14)
3-25	Bedrock	60	1760	340
(1-8)	Unit A	(18)	(710)	(310)
25-50	Bedrock	60	4500	860
(8-15)	Unit A	(18)	(1820)	(780)
			6300	1220
			(2550)	(1110)
0-3	Bedrock	60	155	34
(0-1)	Unit H	(18)	(63)	(31)
			155	34
			(63)	(31)
0-3	Bedrock	60	10,400	2250
(0-1)	Unit J	(18)	(4200)	(2040)
3-25	Bedrock	60	2500	540
(1-8)	Unit J	(18)	(1010)	(490)
25-50	Bedrock	60	710	153
(8-15)	Unit J	(18)	(285)	(139)
			13,600	2950
			(5500)	(2700)
			20,100	4200
			(8100)	(3800)

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 4. TOTAL IDENTIFIED BEDROCK RESOURCES, SAULT STE. MARIE AREA

1 DRIFT THICKNESS Feet (Metres)	2 FORMATION	3 ESTIMATED DEPOSIT THICKNESS Feet (Metres)	4 AREAL EXTENT Acres (Hectares)	5 ORIGINAL TONNAGE Millions of Tons (Tonnes)
Corporation of the Township of Prince				
0-3	Bedrock	60	246	47
(0-1)	Unit A	(18)	(100)	(43)
3-25	Bedrock	60	71	14
(1-8)	Unit A	(18)	(29)	(13)
25-50	Bedrock	60	65	12
(8-15)	Unit A	(18)	(26)	(11)
			380	73
			(154)	(66)
0-3	Bedrock	60	48	10
(0-1)	Unit B	(18)	(19)	(9)
3-25	Bedrock	60	4	1
(1-8)	Unit B	(18)	(2)	(1)
25-50	Bedrock	60	12	2
(8-15)	Unit B	(18)	(5)	(2)
			64	13
			(26)	(12)
0-3	Bedrock	60	199	45
(0-1)	Unit C	(18)	(80)	(41)
			199	45
			(80)	(41)
0-3	Bedrock	60	14,500	3150
(0-1)	Unit J	(18)	(5900)	(2850)
3-25	Bedrock	60	2320	500
(1-8)	Unit J	(18)	(940)	(455)
25-50	Bedrock	60	155	34
(8-15)	Unit J	(18)	(63)	(31)
			17,000	3700
			(6900)	(3350)
			17,600	3850
			(7100)	(3500)
Kars Township				
0-3	Bedrock	60	3050	590
(0-1)	Unit A	(18)	(1230)	(540)
3-25	Bedrock	60	1390	265
(1-8)	Unit A	(18)	(560)	(240)
25-50	Bedrock	60	5200	1000
(8-15)	Unit A	(18)	(2100)	(910)
			9600	1860
			(3900)	(1690)
25-50	Bedrock	60	52	12
(8-15)	Unit E	(18)	(21)	(11)
			52	12
			(21)	(11)
			9600	1870
			(3900)	(1700)

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 4. TOTAL IDENTIFIED BEDROCK RESOURCES, SAULT STE. MARIE AREA

1 **DRIFT THICKNESS** Feet (Metres)	2 **FORMATION**	3 **ESTIMATED DEPOSIT THICKNESS** Feet (Metres)	4 **AREAL EXTENT** Acres (Hectares)	5 **ORIGINAL TONNAGE** Millions of Tons (Tonnes)
Fenwick Township				
0-3	Bedrock	60	1030	198
(0-1)	Unit A	(18)	(415)	(180)
3-25	Bedrock	60	325	62
(1-8)	Unit A	(18)	(132)	(56)
25-50	Bedrock	60	310	60
(8-15)	Unit A	(18)	(126)	(54)
			1660	320
			(670)	(290)
0-3	Bedrock	60	20	4
(0-1)	Unit E	(18)	(8)	(4)
3-25	Bedrock	60	15	3
(1-8)	Unit E	(18)	(6)	(3)
			35	7
			(14)	(6)
0-3	Bedrock	60	450	100
(0-1)	Unit F	(18)	(182)	(91)
3-25	Bedrock	60	34	8
(1-8)	Unit F	(18)	(14)	(7)
25-50	Bedrock	60	46	10
(8-15)	Unit F	(18)	(19)	(9)
			530	118
			(214)	(107)
0-3	Bedrock	60	2800	640
(0-1)	Unit K	(18)	(1130)	(580)
3-25	Bedrock	60	305	70
(1-8)	Unit K	(18)	(123)	(64)
25-50	Bedrock	60	92	21
(8-15)	Unit K	(18)	(37)	(19)
			3200	730
			(1300)	(660)
			5400	1180
			(2180)	(1070)

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 4. TOTAL IDENTIFIED BEDROCK RESOURCES, SAULT STE. MARIE AREA

1 **DRIFT THICKNESS** Feet (Metres)	2 **FORMATION**	3 **ESTIMATED DEPOSIT THICKNESS** Feet (Metres)	4 **AREAL EXTENT** Acres (Hectares)	5 **ORIGINAL TONNAGE** Millions of Tons (Tonnes)
Van Koughnet Township				
0-3	Bedrock	60	44	8
(0-1)	Unit A	(18)	(18)	(7)
3-25	Bedrock	60	139	27
(1-8)	Unit A	(18)	(56)	(24)
25-50	Bedrock	60	380	73
(8-15)	Unit A	(18)	(154)	(66)
			560	108
			(227)	(98)
0-3	Bedrock	60	1690	405
(0-1)	Unit D	(18)	(680)	(365)
3-25	Bedrock	60	247	59
(1-8)	Unit D	(18)	(100)	(54)
			1940	465
			(780)	(420)
0-3	Bedrock	60	1790	395
(0-1)	Unit E	(18)	(720)	(360)
3-25	Bedrock	60	116	26
(1-8)	Unit E	(18)	(47)	(24)
25-50	Bedrock	60	84	19
(8-15)	Unit E	(18)	(34)	(17)
			1990	440
			(800)	(400)
0-3	Bedrock	60	3850	860
(0-1)	Unit F	(18)	(1560)	(780)
3-25	Bedrock	60	1150	255
(1-8)	Unit F	(18)	(465)	(231)
25-50	Bedrock	60	860	191
(8-15)	Unit F	(18)	(350)	(173)
			5900	1310
			(2390)	(1190)
0-3	Bedrock	60	32	7
(0-1)	Unit H	(18)	(13)	(6)
3-25	Bedrock	60	15	3
(1-8)	Unit H	(18)	(6)	(3)
			47	10
			(19)	(9)
0-3	Bedrock	60	239	54
(0-1)	Unit I	(18)	(97)	(49)
3-25	Bedrock	60	88	20
(1-8)	Unit I	(18)	(36)	(18)
			325	74
			(132)	(67)
0-3	Bedrock	60	960	207
(0-1)	Unit J	(18)	(390)	(188)
3-25	Bedrock	60	32	7
(1-8)	Unit J	(18)	(13)	(6)
			990	214
			(400)	(194)

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 4. TOTAL IDENTIFIED BEDROCK RESOURCES, SAULT STE. MARIE AREA

1 **DRIFT THICKNESS** Feet (Metres)	2 **FORMATION**	3 **ESTIMATED DEPOSIT THICKNESS** Feet (Metres)	4 **AREAL EXTENT** Acres (Hectares)	5 **ORIGINAL TONNAGE** Millions of Tons (Tonnes)
0-3	Bedrock	60	2400	550
(0-1)	Unit K	(18)	(970)	(500)
3-25	Bedrock	60	590	134
(1-8)	Unit K	(18)	(239)	(122)
25-50	Bedrock	60	325	74
(8-15)	Unit K	(18)	(132)	(67)
			3300	760
			(1340)	(690)
			15,100	3400
			(6100)	(3100)
Dennis Township				
0-3	Bedrock	60	1020	196
(0-1)	Unit A	(18)	(415)	(178)
3-25	Bedrock	60	99	19
(1-8)	Unit A	(18)	(40)	(17)
25-50	Bedrock	60	290	56
(8-15)	Unit A	(18)	(117)	(51)
			1410	270
			(570)	(245)
0-3	Bedrock	60	790	171
(0-1)	Unit J	(18)	(320)	(155)
3-25	Bedrock	60	3150	680
(1-8)	Unit J	(18)	(1280)	(620)
			3950	850
			(1600)	(770)
			5400	1120
			(2180)	(1020)
Pennefather Township				
0-3	Bedrock	60	84	16
(0-1)	Unit A	(18)	(34)	(14)
3-25	Bedrock	60	87	17
(1-8)	Unit A	(18)	(35)	(15)
25-50	Bedrock	60	355	68
(8-15)	Unit A	(18)	(144)	(62)
			530	101
			(214)	(92)
0-3	Bedrock	60	15,800	3400
(0-1)	Unit J	(18)	(6400)	(3100)
3-25	Bedrock	60	3350	720
(1-8)	Unit J	(18)	(1360)	(650)
25-50	Bedrock	60	50	11
(8-15)	Unit J	(18)	(20)	(10)
			19,200	4150
			(7800)	(3750)
			19,700	4250
			(8000)	(3850)

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 4. TOTAL IDENTIFIED BEDROCK RESOURCES, SAULT STE. MARIE AREA

1 **DRIFT THICKNESS** Feet (Metres)	2 **FORMATION**	3 **ESTIMATED DEPOSIT THICKNESS** Feet (Metres)	4 **AREAL EXTENT** Acres (Hectares)	5 **ORIGINAL TONNAGE** Millions of Tons (Tonnes)
Aweres Township				
3-25	Bedrock	60	135	26
(1-8)	Unit A	(18)	(55)	(24)
25-50	Bedrock	60	195	37
(8-15)	Unit A	(18)	(79)	(34)
			330	63
			(134)	(57)
0-3	Bedrock	60	6400	1420
(0-1)	Unit H	(18)	(2600)	(1290)
3-25	Bedrock	60	235	52
(1-8)	Unit H	(18)	(95)	(47)
25-50	Bedrock	60	60	13
(8-15)	Unit H	(18)	(24)	(12)
			6700	1490
			(2700)	(1350)
0-3	Bedrock	60	920	210
(0-1)	Unit I	(18)	(370)	(190)
3-25	Bedrock	60	12	3
(1-8)	Unit I	(18)	(5)	(3)
			930	213
			(375)	(193)
0-3	Bedrock	60	7400	1600
(0-1)	Unit J	(18)	(3000)	(1450)
3-25	Bedrock	60	3100	670
(1-8)	Unit J	(18)	(1260)	(610)
25-50	Bedrock	60	920	199
(8-15)	Unit J	(18)	(370)	(180)
			11,400	2470
			(4600)	(2240)
			19,400	4250
			(7800)	(3850)
			104,000	22,300
			(42 000)	(20 200)

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 5. QUARRIES, SAULT STE. MARIE AREA.

1 NO.	2 MTC NO.	3 OWNER/ OPERATOR	4 LOT	5 CON.	6 LICENCED AREA Acres (Hectares)	7 FACE HEIGHT Feet (Metres)
1	S10-091	Mr. Edward Kosiba	SW 1/4 of SW 1/4, Section 17		20.5 (8.3)	0-6 (0-2)
					20.5 (8.3)	

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 6. SELECTED BEDROCK RESOURCE AREAS, SAULT STE. MARIE AREA.

1 **DEPOSIT NO.**	2 **DEPTH OF OVERBURDEN** Feet (Metres)	3 **AREA** Acres (Hectares)	4 **CULTURAL SETBACKS** Acres (Hectares)	5 **EXTRACTED AREA** Acres (Hectares)	6 **AVAILABLE AREA** Acres (Hectares)	7 **ESTIMATED QUARRIABLE THICKNESS** Feet (Metres)	8 **AVAILABLE RESOURCES** Millions of Tons (Tonnes)
-NONE-							

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 7. SUMMARY OF TEST HOLE DATA, SAULT STE. MARIE AREA.

CITY OF SAULT STE. MARIE

Test Hole Number: SSM-TH-1 (SSM-78-1)
Location: City of Sault Ste. Marie (Korah Twp.), Section 21 (SW 1/4)
Elevation: Approx. 775 feet (236 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-32 (0-10)	fine sand with some medium and coarse sand occurrences; dry
32-38 (10-12)	medium sand interbedded with fine gravel; dry
38-44 (12-13)	medium sand; dry
44-47 (13-14)	medium sand with fine gravel; moist
47-52 (14-16)	fine sand
	end of hole at 52 feet (16 m)

Test Hole Number: SSM-TH-2 (SSM-78-2)
Location: City of Sault Ste. Marie (Korah Twp.), Section 20 (NE 1/4)
Elevation: Approx. 800 feet (244 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-7 (0-2)	medium sand with 10% fine gravel and cobbles to 4 inches (102 mm)
7-40 (2-12)	medium sand with minor coarse sand to fine gravel
40-52 (12-16)	medium sand with 5% to 25% coarse gravel in 1 inch range (25.4 mm)
	end of hole at 52 feet (16 m)

Test Hole Number: SSM-TH-3 (SSM-78-3)
Location: City of Sault Ste. Marie (Korah Twp.), Section 21 (NW 1/4)
Elevation: Approx. 800 feet (244 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-9 (0-3)	medium to fine sand; dry
9-29.5 (3-9.0)	fine sand, laminated; moist with water in hole at 20 to 22 feet (6 to 7 m)
29.5-42 (9.0-13)	fine sand, laminated with red silt-clay laminae and silt interbeds; saturated at 40 to 42 feet (12 to 13 m)
42-52 (13-16)	fine sand, saturated
	end of hole

Test Hole Number: SSM-TH-4 (SSM-78-4 & 4a)
Location: City of Sault Ste. Marie (Korah Twp.), Section 16 (SW 1/4)
Elevation: Approx. 900 feet (274 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-21.5 (0-6.6)	coarse to medium sand with 5% gravel in the 1 inch (25.4 mm) range at 10 to 15 feet (3 to 5 m). Water at 2 feet (0.6 m) below surface. Pink stony sandy silt till at bottom of test hole.
	end of hole at 21.5 feet (6.6 m)

Test Hole Number: SSM-TH-5 & 5a (SSM-78-5 & 5a)
Location: City of Sault Ste. Marie (Korah Twp.), Section 16 (NE 1/4)
Elevation: Approx. 1000 feet (305 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-5 (0-1.5)	coarse gravel in 2 to 3 inch (50.8 to 76.2 mm) size range
5-20 (1.5-6)	medium to coarse sand with fine gravel. Water in hole at 15 feet (5 m). Note: Test hole was drilled 10 feet (3 m) north of test hole 5: fine gravel encountered to 15 feet (5 m)
	end of hole at 20 feet (6 m)

N.B. Minor variations in all tables are caused by rounding of data.

Note: Test hole data presented in this table is a condensed version of previously published bore hole logs in Ontario Geological Survey Open File Report 5258. Test hole numbers in brackets refer to the original borehole numbers in the above report.

TABLE 7. SUMMARY OF TEST HOLE DATA, SAULT STE. MARIE AREA

Test Hole Number: SSM-TH-5b (SSM-78-5b)
Location: City of Sault Ste. Marie (Koran Twp.), Section 16 (SE 1/4)
Elevation: Approx. 975 feet (297 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-11 (0-3)	gravel and medium to coarse sand; water at 5 feet (1.5 m)
	end of hole at 11 feet (3 m)

Test Hole Number: SSM-TH-6 (SSM-78-6)
Location: City of Sault Ste. Marie (Korah Twp.), Section 22 (NW 1/4)
Elevation: Approx. 850 feet (259 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-52 (0-16)	medium to fine sand, laminated; moist throughout test hole
	end of hole at 52 feet (16 m)

Test Hole Number: SSM-TH-7 (SSM-78-7)
Location: City of Sault Ste. Marie (Korah Twp.), Section 14 (SW 1/4)
Elevation: Approx. 925 feet (282 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-14 (0-4)	medium sand with minor coarse sand; dry
14-52 (4-16)	fine sand, laminated; moist with some coarse sand
	end of hole at 52 feet (16 m)

Test Hole Number: SSM-TH-8 (SSM-78-8)
Location: City of Sault Ste. Marie (Korah Twp.), Section 13 (SW 1/4)
Elevation: Approx. 890 feet (271 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-3 (0-1)	medium to fine sand
3-4 (1-1.2)	gravel layer
4-11 (1.2-3)	medium to fine sand with trace of fine gravel
11-22 (3-7)	gravelly medium sand, cobbles retrieved from auger flights
	end of hole at 22 feet (7 m)

Test Hole Number: SSM-TH-9 (SSM-78-9)
Location: City of Sault Ste. Marie (Korah Twp.), Section 13 (NW 1/4)
Elevation: Approx. 950 feet (290 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-25 (0-8)	medium to medium-fine sand with 15% gravel; dry
25-65 (8-20)	fine sand, stratified and weakly laminated with some coarse-fine gravel; moist
65-69 (20-21)	gravelly medium-coarse sand
	end of hole at 69 feet (21 m) in gravel

Test Hole Number: SSM-TH-10 (SSM-78-10)
Location: City of Sault Ste. Marie (Korah Twp.), Section 12 (SW 1/4)
Elevation: Approx. 1000 feet (305 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-14 (0-4)	cobble-to boulder-sized gravel up to 10 inches (254 mm) with some coarse sand
14-23 (4-7)	medium-fine sand
	end of hole at 23 feet (7 m), possibly on bedrock

N.B. Minor variations in all tables are caused by rounding of data.

Note: Test hole data presented in this table is a condensed version of previously published bore hole logs in Ontario Geological Survey Open File Report 5256. Test hole numbers in brackets refer to the original borehole numbers in the above report.

TABLE 7. SUMMARY OF TEST HOLE DATA, SAULT STE. MARIE AREA.

Test Hole Number: SSM-TH-11 (SSM-78-11)
Location: City of Sault Ste. Marie (Korah Twp.), Section 13 (SW 1/4)
Elevation: Approx. 900 feet (274 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-1 (0-0.3)	road fill
1-11 (0.3-3)	fine-medium sand, laminated
11-14 (3-4)	gravel
14-52 (4-16)	medium sand with minor gravel, stratified, moist, some minor fine gravel to coarse sand at 42 to 50 feet (13 to 15 m)
	end of hole at 52 feet (16 m)

Test Hole Number: SSM-TH-12 (SSM-78-12)
Location: City of Sault Ste. Marie (Korah Twp.), Section 13 (NE 1/4)
Elevation: Approx. 900 feet (274 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-19 (0-6)	gravelly coarse-medium sand, laminated; dry
19-22 (6-7)	gravelly medium sand; dry
22-52 (7-16)	medium sand with interbeds of gravel and laminated sand, some coarse sand; dry gravel layers at 36 feet (11 m), 42 feet (13 m) and 44 feet (13 m)
	end of hole at 52 feet (16 m)

Test Hole Number: SSM-TH-13 (SSM-78-13)
Location: City of Sault Ste. Marie (Korah Twp.), Section 12 (SE 1/4)
Elevation: Approx. 900 feet (274 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-6 (0-2)	interbedded medium sand and gravel
6-15 (2-5)	medium sand
15-52 (5-16)	fine sand interbedded with fine-medium sand; dry. Thin beds of silty fine sand. Pale brown colour boundary at 32 feet (10 m). Change to reddish brown to orange. Moist at 35 feet (11 m) to bottom of hole.
	end of hole at 52 feet (16 m)

Test Hole Number: SSM-TH-14 (SSM-78-14)
Location: City of Sault Ste. Marie (Korah Twp.), Section 12 (NE 1/4)
Elevation: Approx. 1000 feet (305 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-4 (0-1.2)	cobble gravel
	end of hole at 4 feet (1.2 m) due to auger refusal on bedrock

Test Hole Number: SSM-TH-15 (SSM-78-15)
Location: City of Sault Ste Marie (Tarentorus Twp.), Section 18 (NW 1/4)
Elevation: Approx. 900 feet (274 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-52 (0-16)	silty fine sand, laminated, dense, saturated at 34 feet (10 m) some trace of gravel from 45 feet to 52 feet (14 to 16 m)
	end of hole at 52 feet (16 m)

N.B. Minor variations in all tables are caused by rounding of data.

Note: Test hole data presented in this table is a condensed version of previously published bore hole logs in Ontario Geological Survey Open File Report 5258. Test hole numbers in brackets refer to the original borehole numbers in the above report.

TABLE 7. SUMMARY OF TEST HOLE DATA, SAULT STE. MARIE AREA.

Test Hole Number: SSM-TH-16 (SSM-78-16 & 16a)
Location: City of Sault Ste. Marie (Tarentorus Twp.), Section 7 (SW 1/4)
Elevation: Approx. 1000 feet (305 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-8 (0-2)	gravelly coarse-medium sand; moist
8-20 (2-6)	gravel with sand
20-46 (6-14)	medium sand with fine gravel interbedded: saturation at 29 feet (9 m) 5% to 10% fine gravel estimated
46-57 (14-17)	medium sand with gravel 55 to 57 feet (16.8 to 17.4 m), auger refusal at 57 feet (17 m) possibly caused by boulder or coarse cobbles
	end of hole at 57 feet (17 m)

Test Hole Number: SSM-TH-17a (SSM-78-17a)
Location: City of Sault Ste. Marie (Tarentorus Twp.), Section 8 (NW 1/4)
Elevation: Approx. 950 feet (290 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-3.5 (0-1.1)	coarse gravel
	end of hole at 3.5 feet (1.1 m); moved to location 17b

Test Hole Number: SSM-TH-17b (SSM-78-17b)
Location: City of Sault Ste. Marie (Tarentorus Twp.), Section 8 (NW 1/4)
Elevation: Approx. 950 feet (290 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-7 (0-2)	medium sand with minor fine gravel to coarse sand: dry
7-18 (2-5)	gravelly coarse sand to sandy gravel saturation at 18 feet (5 m)
18-52 (5-16)	medium sand with coarse sand to fine gravel; wet
	end of hole at 52 feet (16 m)

Test Hole Number: SSM-TH-18 (SSM-78-18)
Location: City of Sault Ste. Marie (Tarentorus Twp.), Section 9 (NW 1/4)
Elevation: Approx. 1010 feet (308 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-1 (0-0.3)	soil
1-11 (0.3-3)	medium-coarse sand with fine gravel; dry
11-16 (3-5)	gravelly coarse-medium sand: dry
16-19.5 (5-5.9)	gravel
	end of hole at 19.5 feet (5.9 m)

Test Hole Number: SSM-TH-19 (SSM-78-19)
Location: City of Sault Ste. Marie (Tarentorus Twp.), Section 17 (NE 1/4)
Elevation: Approx. 900 feet (274 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-52 (0-16)	fine to medium sand, weakly bedded with some laminations; dry intermittently moist, some fine gravel
	end of hole at 52 feet (16 m)

Test Hole Number: SSM-TH-20 (SSM-78-20)
Location: City of Sault Ste. Marie (Tarentorus Twp.), Section 10 (NW 1/4)
Elevation: Approx. 1000 feet (305 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-4 (0-1.2)	coarse gravel with cobbles
	end of hole at 4 feet (1.2 m)

N.B. Minor variations in all tables are caused by rounding of data.

Note: Test hole data presented in this table is a condensed version of previously published bore hole logs in Ontario Geological Survey Open File Report 5258. Test hole numbers in brackets refer to the original borehole numbers in the above report.

TABLE 7. SUMMARY OF TEST HOLE DATA, SAULT STE. MARIE AREA.

Test Hole Number: SSM-TH-21 (SSM-78-21)
Location: City of Sault Ste. Marie (Tarentorus Twp.), Section 9 (SE 1/4)
Elevation: Approx. 975 feet (297 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-2 (0-0.6)	soil
2-52 (0.6-16)	medium sand with gravel and cobbles to 32 feet (10 m)
	end of hole at 52 feet (16 m)

Test Hole Number: SSM-TH-22 (SSM-78-22)
Location: City of Sault Ste. Marie (Tarentorus Twp.), Section 9 (NE 1/4)
Elevation: Approx. 1000 feet (305 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-5 (0-1.5)	cobble gravel; dry
5-14 (1.5-4)	medium sand with coarse-fine gravel and cobbles at 10 feet (3 m); dry
14-40 (4-12)	fine sand, laminated, wet and saturated to 30 feet (9 m)
40-52 (12-16)	fine gravelly sand, 40 to 47 feet (12.2 to 14.3 m), gravel bed at 47 to 48 feet (14.3 to 14.6 m), fine sand with fine gravel 48 to 52 feet (14.6 to 15.9 m)
	end of hole at 52 feet (16 m)

Test Hole Number: SSM-TH-23 (SSM-78-23)
Location: City of Sault Ste. Marie (Tarentorus Twp.), Section 16 (NW 1/4)
Elevation: Approx. 900 feet (274 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-3 (0-1)	gravelly medium sand, possibly road fill
3-47 (1-14)	medium sand, minor gravel; dry
47-52 (14-16)	fine sand interbedded with medium sand; dry
	end of hole at 52 feet (16 m)

Test Hole Number: SSM-TH-24 (SSM-78-24)
Location: City of Sault Ste. Marie (Tarentorus Twp.), Section 8 (SW 1/4)
Elevation: Approx. 900 feet (274 m) a.s.l.
Date: August 1978

Depth feet (metres)	Description
0-2 (0-0.6)	road fill
2-13 (0.6-4)	fine sand, laminated; dry
13-19 (4-6)	medium sand, saturated
19-22 (6-7)	gravel
	end of hole at 22 feet (7 m)

N.B. Minor variations in all tables are caused by rounding of data.

Note: Test hole data presented in this table is a condensed version of previously published bore hole logs in Ontario Geological Survey Open File Report 5258. Test hole numbers in brackets refer to the original borehole numbers in the above report.

TABLE 8. SUMMARY OF GEOPHYSICS DATA, SAULT STE. MARIE AREA.

AWERES TOWNSHIP

Line Number: SSM-GT-1
Line Direction: N 45° W
Method: Hammer Seismic (Nimbus ES-125)
Location: Aweres Township, Section 17, SW 1/4
Date: July 12, 1983
Elevation: Approx. 1150 feet (350 m) a.s.l.
Geology: Glaciofluvial outwash deposit
Seismic Data:

Number of Layers:	Three
Layer velocities:	V_1= 1850 ft./sec. (560 m/sec.) V_2= 4000 ft./sec. (1220 m/sec.) V_3= 6700 ft./sec. (2040 m/sec.)
Layer thickness:	D_1= 3 ft. (1 m) D_2= 18 ft. (5.5 m)

Interpretation: Approx. 3 feet (1 m) of dry sand and gravel underlain by 18 feet (6 m) of wet sand and gravel. Bedrock is suspected below 18 feet (5.5 m).

Line Number: SSM-GT-2
Line Direction: N 45° W
Method: Hammer Seismic (Nimbus ES-125)
Location: Aweres Township, Section 20, NW 1/4
Date: July 12, 1983
Elevation: Approx. 1150 feet (350 m) a.s.l.
Geology: Glaciofluvial outwash deposit
Seismic Data:

Number of Layers:	Three
Layer velocities:	V_1= 1500 ft.sec. (455 m/sec.) V_2= 4000 ft./sec. (1220 m/sec.) V_3= 6850 ft./sec. (2090 m/sec.)
Layer thickness:	D_1= 6 ft. (1.8 m) D_2= 11 ft. (3.4 m)

Interpretation: Approx. 6 feet (1.8 m) of dry sand and gravel over 11 feet (3.4 m) of wet sand and gravel lying on suspected irregular bedrock surface.

Line Number: SSM-GT-3
Line Direction: N 20° E
Method: Hammer Seismic (Nimbus ES-125)
Location: Aweres Township, Section 21, NW 1/4
Date: July 12, 1983
Elevation: Approx. 1100 feet (335 m) a.s.l.
Geology: Glaciofluvial outwash deposit
Seismic Data:

Number of Layers:	Two
Layer velocities:	V_1= 2300 ft./sec. (700 m/sec.) V_2= 5000 ft./sec. (1520 m/sec.)
Layer thickness:	D_1= 15.5 ft. (4.7 m)

Interpretation: Approx. 15.5 feet (4.7 m) of dry sand and gravel underlain by wet silty sand and gravel.

Line Number: SSM-GT-4
Line Direction: N 45° W
Method: Hammer Seismic (Nimbus ES-125)
Location: Aweres Township, Section 20, SE 1/4
Date: July 12, 1983
Elevation: Approx. 1075 feet (328 m) a.s.l.
Geology: Glaciofluvial outwash deposit
Seismic Data:

Number of Layers:	Three
Layer velocities:	V_1= 2000 ft./sec. (610 m/sec.) V_2= 5600 ft./sec. (1710 m/sec.) V_3= 20,000 ft./sec. (6100 m/sec.)
Layer thickness:	D_1= 7.5 ft. (2.3 m) D_2= 26.5 ft. (8.1 m)

Interpretation: Approx. 7.5 feet (2.3 m) of dry sand and gravel over 26.5 feet (8.1 m) of wet, bouldery sand and gravel over irregular bedrock surface.

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 8. SUMMARY OF GEOPHYSICS DATA, SAULT STE. MARIE AREA.

CITY OF SAULT STE. MARIE

Line Number: SSM-GT-5
Line Direction: N 90° E
Method: Hammer Seismic (Nimbus ES-125)
Location: City of Sault Ste. Marie (Korah Twp.), Section 8, NW 1/4
Date: July 14, 1983
Elevation: Approx. 1075 feet (328 m) a.s.l.
Geology: Glaciofluvial outwash deposit
Seismic Data:

Number of Layers:	Two
Layer velocities:	V_1 = 1540 ft./sec. (470 m/sec.)
	V_2 = 15,000 ft./sec. (4570 m/sec.)
Layer thickness:	D_1 = 18 ft. (5.5 m)

Interpretation: Approx. 18 feet (5.5 m) of dry sand and gravel over irregular bedrock surface.

Line Number: SSM-GT-6
Line Direction: N 45° E
Method: Hammer Seismic (Nimbus ES-125)
Location: City of Sault Ste. Marie (Tarentorus Twp.) Section 9, SE 1/4
Date: July 15, 1983
Elevation: Approx. 1000 feet (305 m) a.s.l.
Geology: Glaciolacustrine beach-outwash delta complex
Seismic Data:

Number of Layers:	Three
Layer velocities:	V_1 = 1540 ft./sec. (470 m/sec.)
	V_2 = 3600 ft./sec. (1100 m/sec.)
	V_3 = 15,000 ft./sec. (4570 m/sec.)
Layer thickness:	D_1 = 14 ft. (4.3 m)
	D_2 = 52 ft. (15.8 m)

Interpretation: Approx. 14 feet (4.3 m) of gravelly sand underlain by a minimum of 52 feet (15.8 m) of dry gravel. The gravel is probably underlain by bedrock.

Line Number: SSM-GT-7
Line Direction: N 45° E
Method: Hammer Seismic (Nimbus ES-125)
Location: City of Sault Ste. Marie. (Tarentorus Twp.), Section 9, NE 1/4
Date: July 8, 1983
Elevation: Approx. 1000 feet (305 m) a.s.l.
Geology: Glaciolacustrine beach-outwash delta complex
Seismic Data:

Number of Layers:	One
Layer velocities:	V_1 = 2800 ft./sec. (850 m/sec.)
Layer thickness:	D_1 = 48 ft. (14.6 m) minimum

Interpretation: A minimum of 48 feet (14.6 m) of sand and gravel overlying bedrock at depth.

Line Number: SSM-GT-8
Line Direction: N 45° E
Method: Hammer Seismic (Nimbus ES-125)
Location: City of Sault Ste. Marie (Tarentorus Twp), Section 11, NW 1/4
Date: July 10, 1983
Elevation: Approx. 1000 feet (305 m) a.s.l.
Geology: Glaciolacustrine beach sand deposit
Seismic Data:

Number of Layers:	Two
Layer velocities:	V_1 = 1250 ft./sec. (380 m/sec.)
	V_2 = 11,000 ft./sec. (3350 m/sec.)
Layer thickness:	D_1 = 15 ft. (4.6 m)

Interpretation: Approx. 15 feet (4.6 m) of dry sand over irregular bedrock surface.

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 8. SUMMARY OF GEOPHYSICS DATA, SAULT STE. MARIE AREA.

Line Number: SSM-GT-9
Line Direction: S 60° W
Method: Hammer Seismic (Nimbus ES-125)
Location: City of Sault Ste. Marie (Tarentorus Twp.), Section 9, SE 1/4
Date: July 10, 1983
Elevation: Approx. 1000 feet (305 m) a.s.l.
Geology: Glaciolacustrine sand and gravel deposit
Seismic Data:

Number of Layers:	Three
Layer velocities:	V_1= 1200 ft./sec. (365 m/sec.)
	V_2= 2450 ft./sec. (750 m/sec.)
	V_3= 5000 ft./sec. (1520 m/sec.)
Layer thickness:	D_1= 5 ft. (1.5 m)
	D_2= 35 ft. (10.7 m)

Interpretation: Approx. 5 feet (1.5 m) of dry sand overlying dry stratified sand and gravel to a minimum depth of 35 feet (10.7 m). An irregular bedrock surface is suspected.

Line Number: SSM-GT-10
Line Direction: N 20° W
Method: Hammer Seismic (Nimbus ES-125)
Location: City of Sault Ste. Marie (Parke Twp.), Section 22, NW 1/4
Date: July 20, 1983
Elevation: Approx. 600 feet (183 m) a.s.l.
Geology: Glaciolacustrine plain sand deposit
Seismic Data:

Number of Layers:	Two
Layer velocities:	V_1= 1750 ft./sec. (530 m/sec.)
	V_2= 5000 ft./sec. (1520 m/sec.)
Layer thickness:	D_1= 6 ft. (1.8 m)

Interpretation: Approx. 6 feet (1.8 m) dry sand underlain by wet sand, silt and clay to a minimum depth of 40 feet (12.2 m).

N.B. Minor variations in all tables are caused by rounding of data.

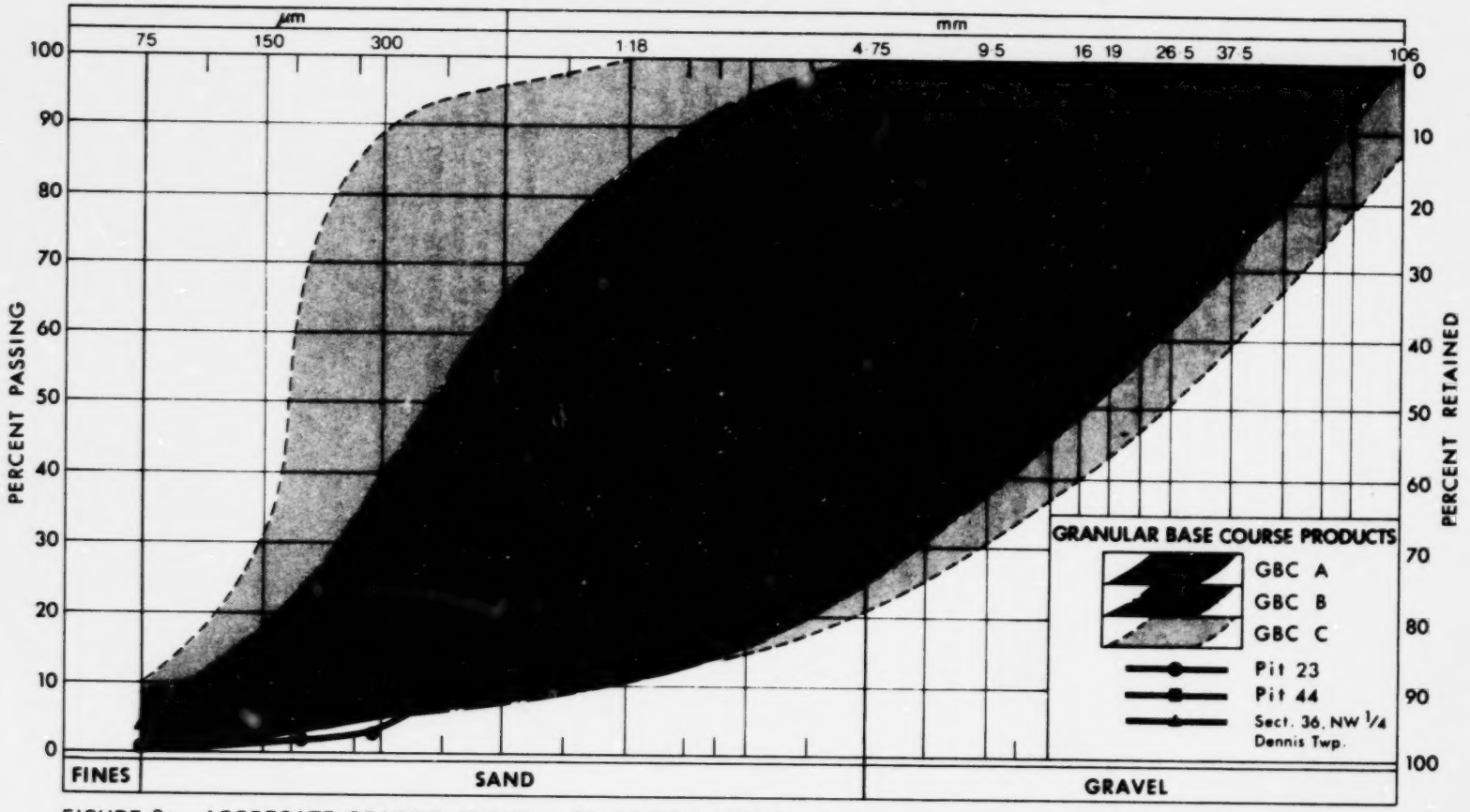

FIGURE 2a: AGGREGATE GRADING CURVES, SAULT STE. MARIE AREA;

Based on analysis of the total aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Form 1010, 1980).

NOTE: Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

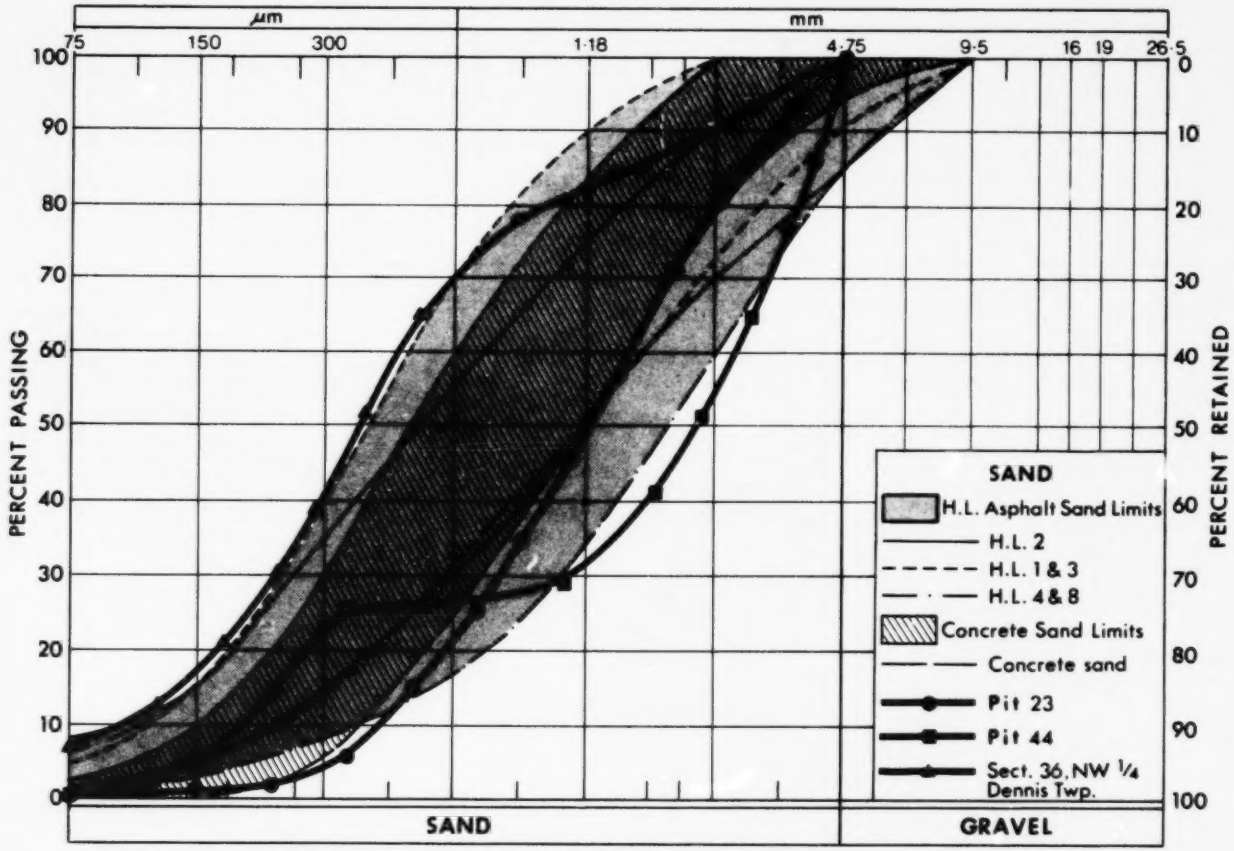

FIGURE 2b: AGGREGATE GRADING CURVES, SAULT STE. MARIE AREA;

Based on analysis of the sand fraction of the aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Forms 1002, 1979 and 1003, 1981).

NOTE:

Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

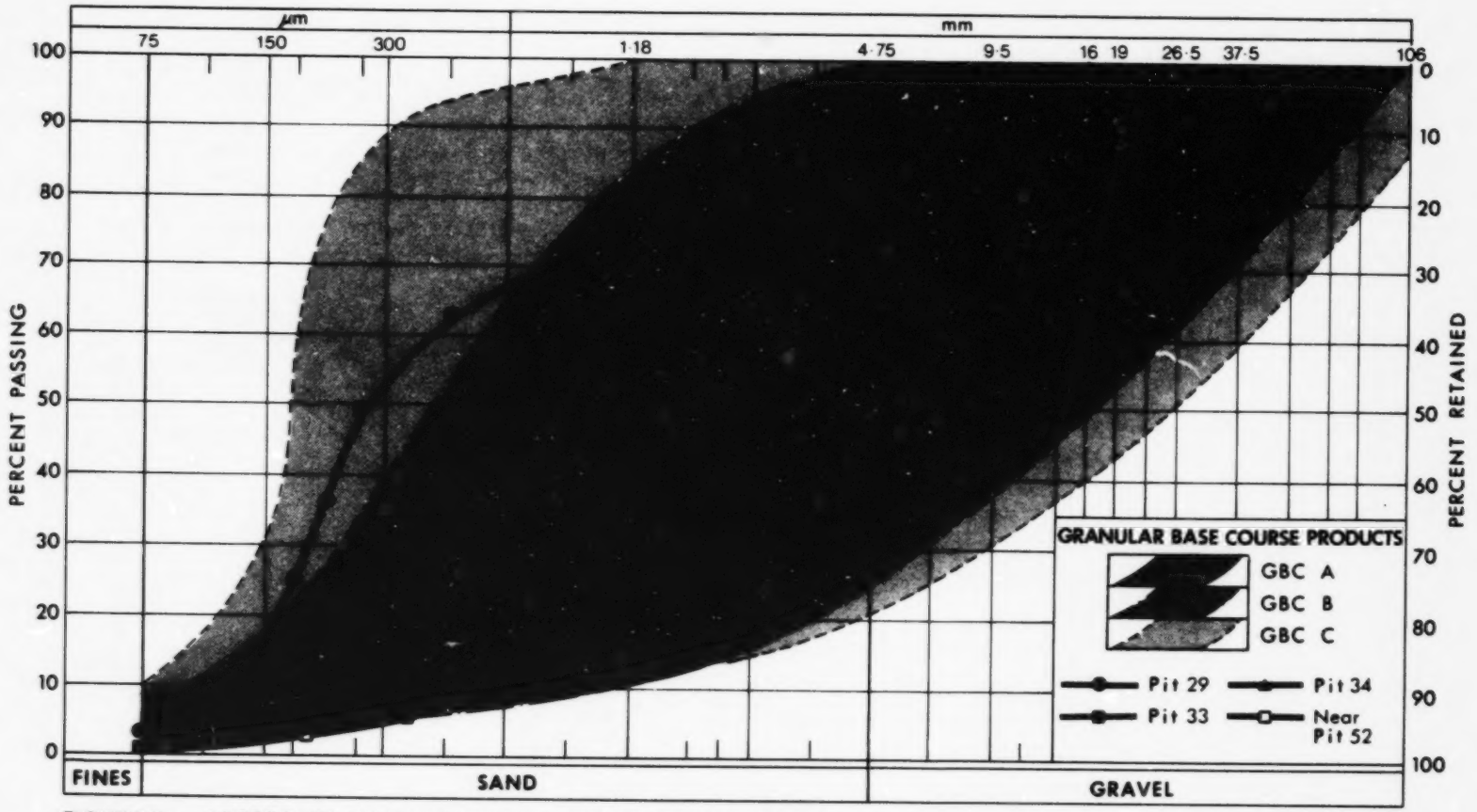

FIGURE 3a: AGGREGATE GRADING CURVES, SAULT STE. MARIE AREA;

Based on analysis of the total aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Form 1010, 1980).

NOTE: Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

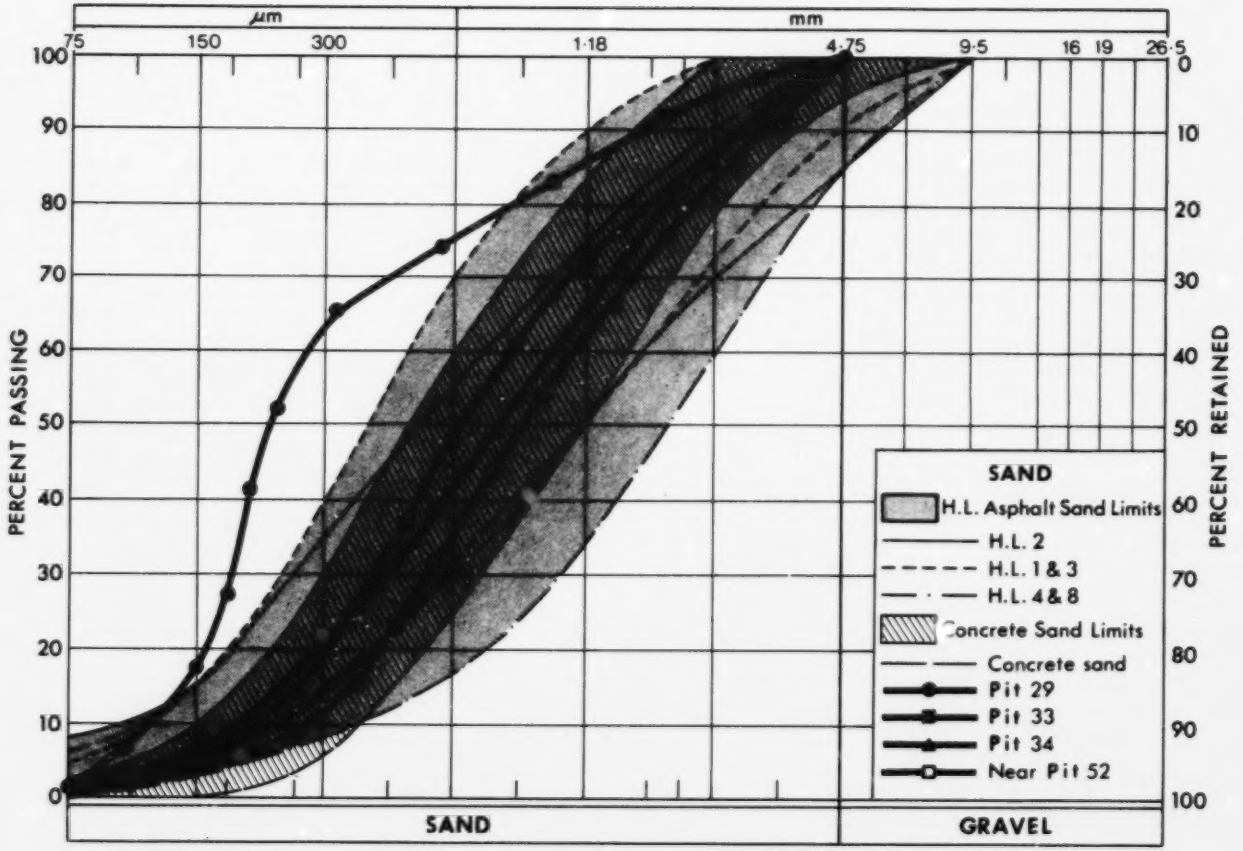

FIGURE 3b: AGGREGATE GRADING CURVES, SAULT STE. MARIE AREA;

Based on analysis of the sand fraction of the aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Forms 1002, 1979 and 1003, 1981).

NOTE:

Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

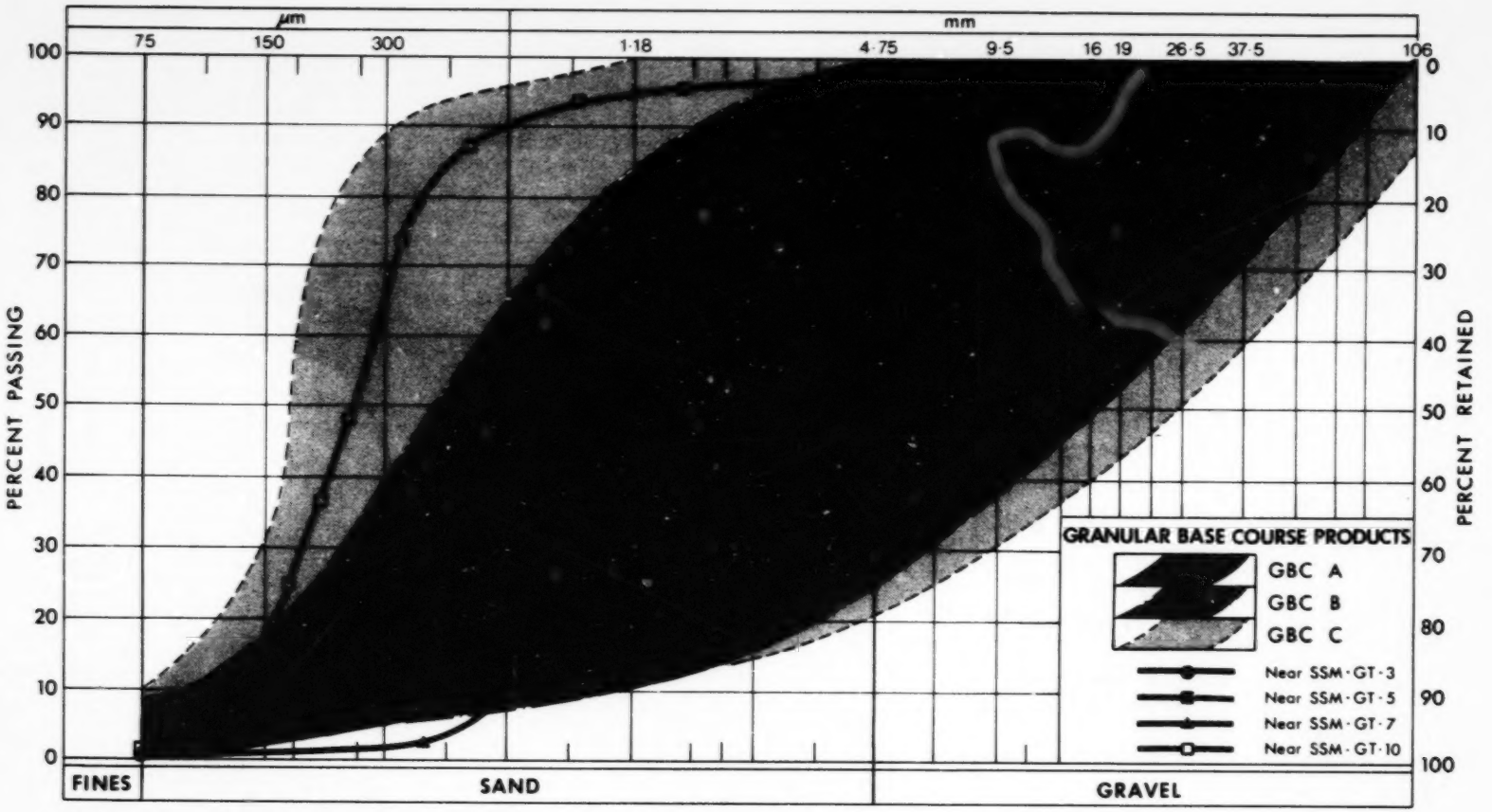

FIGURE 4a: AGGREGATE GRADING CURVES, SAULT STE. MARIE AREA;

Based on analysis of the total aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Form 1010, 1980).

NOTE: Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

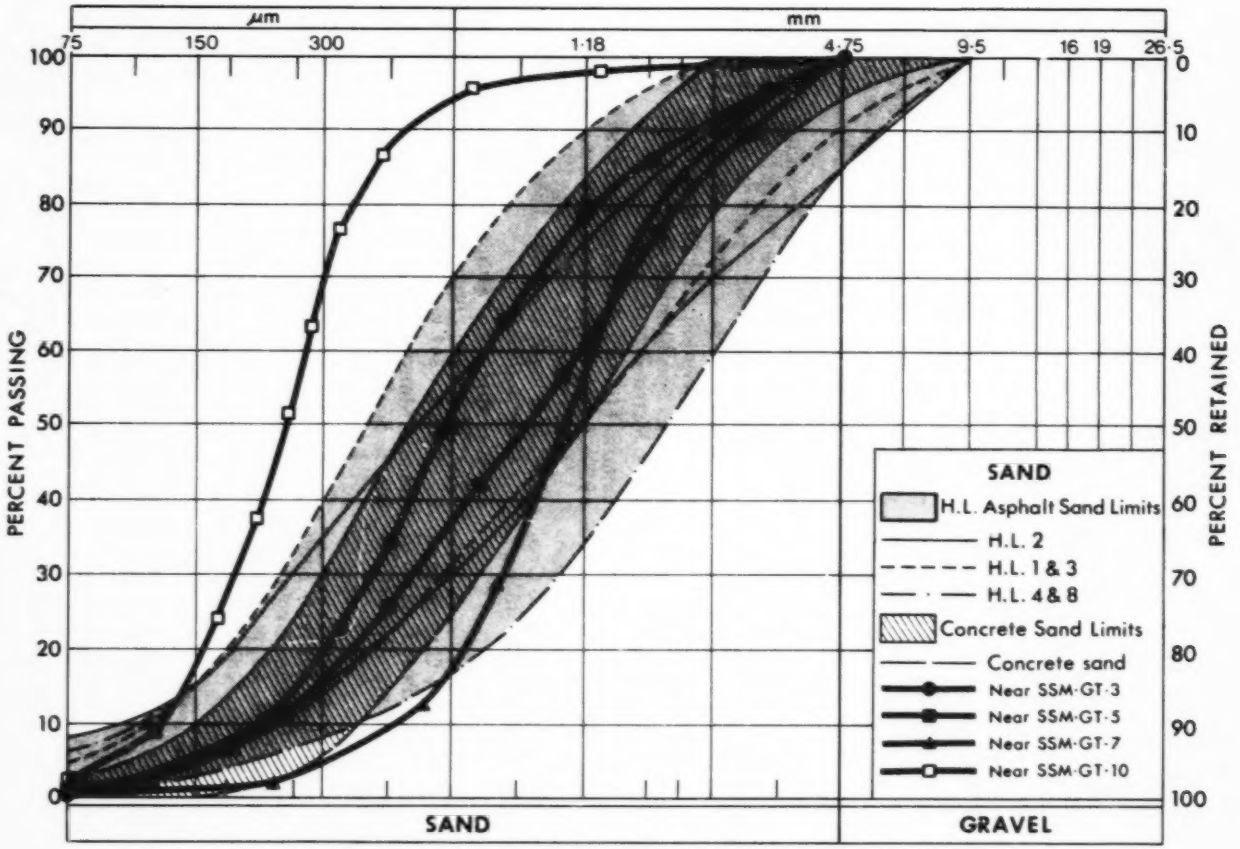

FIGURE 4b: AGGREGATE GRADING CURVES, SAULT STE. MARIE AREA;

Based on analysis of the sand fraction of the aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Forms 1002, 1979 and 1003, 1981).

NOTE:

Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

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Appendix A — Suggested Additional Reading

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Appendix B — Glossary

Abrasion Resistance: Tests such as the Los Angeles Abrasion Test are used to measure the ability of aggregate to resist crushing and pulverizing under conditions similar to those encountered in processing and use. Measuring resistance is an important component in the evaluation of the quality and prospective uses of aggregate. Hard, durable material is preferred for road building.

Absorption Capacity: Related to the porosity of the rock types of which an aggregate is composed. Porous rocks are subject to disintegration when absorbed liquids freeze and thaw, thus decreasing the strength of the aggregate.

Aggregate: Any hard, inert, construction material (sand, gravel, shells, slag, crushed stone or other mineral material) used for mixing in various-sized fragments with a cement or bituminous material to form concrete, mortar, etc., or used alone for road building or other construction. Synonyms include mineral aggregate and granular material.

Alkali-Aggregate Reaction: A chemical reaction between the alkalis of portland cement and certain minerals found in rocks used for aggregate. Alkali-aggregate reactions are undesirable because they can cause expansion and cracking of concrete. Although perfectly suitable for building stone and asphalt applications, alkali-reactive aggregates should be avoided for structural concrete uses.

Blending: Required in cases of extreme coarseness, fineness, or other irregularities in the gradation of unprocessed aggregate. Blending is done with approved sand-sized aggregate in order to satisfy the gradation requirements of the material.

Crushable Aggregate: Unprocessed gravel containing a minimum of 35 percent coarse aggregate larger than the No. 4 sieve (4.75 mm) as well as a minimum of 20 percent greater than the 26.5 mm sieve.

Deleterious Lithology: A general term used to designate those rock types which are chemically or physically unsuited for use as construction or road-building aggregate. Such lithologies as chert, shale, siltstone, and sandstone may deteriorate rapidly when exposed to traffic and other environmental conditions. Similarly, highly weathered, very porous and friable rock can restrict the quality of the aggregate.

Drift: A general term for all unconsolidated rock debris transported from one place and deposited in another, and distinguished from underlying bedrock. In North America, glacial activity has been the dominant mode of transport and deposition of drift. Synonyms include overburden and surficial deposit.

Eolian: Pertaining to the wind, especially with respect to landforms whose constituents were transported and deposited by wind activity. Sand dunes are an example of an eolian landform.

Fines: A general term used to describe the size fraction of an aggregate which passes (is finer than) the No. 200 mesh screen (0.075 mm). Also described informally as "dirt", these particles are in the silt and clay size range.

Gneiss: A coarse-textured metamorphic rock with the minerals arranged in parallel streaks or bands, but lacking schistosity. Gneiss is relatively rich in feldspar. Other common minerals found in this rock include quartz, mica, amphibole and garnet.

Gradation: The proportion of material of each particle size, or the frequency distribution of the various sizes which constitute a sediment. The strength, durability, permeability and stability of an aggregate depend to a great extent on its gradation. The size limits for different particles are as follows:

Boulders	more than 200 mm
Cobbles	75-200 mm
Coarse Gravel	26.5-75 mm
Fine Gravel	4.75-26.5 mm
Coarse Sand	2-4.75 mm
Medium Sand	0.425-2 mm
Fine Sand	0.075-0.425 mm
Silt, Clay	less than 0.075 mm

Granite: is a coarse-grained light coloured rock that ordinarily has an even texture and is composed of quartz and feldspar with either mica, hornblende or both.

Granular Base Course: Components of the pavement structure of a road, which are placed on the subgrade and are designed to provide strength, stability, and drainage, as well as support for surfacing materials. Several types have been defined: Granular Base Course A consists of crushed and processed aggregate and has relatively stringent quality standards in comparison to Granular Base Course B and C which are usually pit-run or other unprocessed aggregate.

Hot-Laid (or Asphaltic) Aggregate: Bituminous, cemented aggregates used in the construction of pavements either as surface or bearing course (H.L. 1, 3, and 4), or as binder course (H.L. 2, 6, and 8) used to bind the surface course to the underlying granular base course.

Lithology: The description of rocks on the basis of such characteristics as colour, structure, mineralogic composition, and grain size. Generally, the description of the physical character of a rock.

Magnesium Sulphate Soundness Test: This test is designed to simulate the action of freezing and thawing on aggregates. Those aggregates which are susceptible will usually break down and give high losses in this test.

Meltwater Channel: A drainage way, usually terraced, produced by water flowing away from a melting glacier margin.

Petrographic Examination: An aggregate quality test based on known field performance of various rock types. The test result is a Petrographic Number (P.N.). The higher the P.N. the lower the quality of aggregate.

Pleistocene: An epoch of the recent geological past including the time from approximately 1.8 million years ago to 7000 years ago. Much of the Pleistocene was characterized by extensive glacial activity and is popularly referred to as the "Great Ice Age".

Possible Resource: Estimates of mineral aggregate material based largely on broad knowledge of the geological character of the deposit and for which there are few, if any, samples or measurements. The estimates are based on assumed continuity or repetition for which there are reasonable geological indications.

Precambrian: The earliest geologic period extending from the consolidation of the earth's crust to the beginning of the Cambrian.

Shale: A fine-grained, sedimentary rock formed by the consolidation of clay, silt, or mud and characterized by well developed bedding planes, along which the rock breaks readily into thin layers. The term shale is also commonly used for fissile claystone, siltstone, and mudstone.

Soundness: The ability of the components of an aggregate to withstand the effects of various weathering processes and agents. Unsound lithologies are subject to disintegration caused by the expansion of absorbed solutions. This may seriously impair the performance of road-building and constructon aggregate.

Till: Unsorted and unstratified rock debris, deposited directly by glaciers, and ranging in size from clay to large boulders.

Wisconsinan: Pertaining to the last glacial stage of the Pleistocene Epoch in North America. It began approximately 100 000 years ago and ended approximately 7000 years ago. The glacial deposits and landforms of Ontario are predominantly the result of glacial activity during the Wisconsinan Stage.

Appendix C — Geology of Sand and Gravel Deposits

The type, distribution, and extent of sand and gravel deposits in Ontario are the result of extensive glacial and glacially influenced activity in Wisconsinan time during the Pleistocene Epoch, approximately 100 000 to 7000 years ago. The deposit types reflect the different depositional environments that existed during the melting and retreat of the continental ice masses, and they can readily be differentiated on the basis of their morphology, structure, and texture. The deposit types are described below.

GLACIOFLUVIAL DEPOSITS

These deposits can be divided into two broad categories: those that were formed in contact with (or in close proximity to) glacial ice, and those that were deposited by meltwaters carrying materials beyond the ice margin.

Ice-Contact Terraces (ICT): These are glaciofluvial features deposited between the glacial margin and a confining topographic high, such as the side of a valley. The structure of the deposits may be similar to that of outwash deposits, but in most cases the sorting and grading of the material are more variable and the bedding is discontinuous because of extensive slumping. The probability of locating large amounts of crushable aggregate is moderate, and extraction may be expensive because of the variability of the deposits both in terms of quality and grain size distribution.

Kames (K): Kames are defined as mounds of poorly sorted sand and gravel deposited by meltwater in depressions or fissures on the ice surface or at its margin. During glacial retreat, the melting of supporting ice causes collapse of the deposits, producing internal structures characterized by bedding discontinuities. The deposits consist mainly of irregularly bedded and crossbedded, poorly sorted sand and gravel. The present forms of the deposits include single mounds, linear ridges (crevasse fillings) or complex groups of landforms. The latter are occasionally described as "undifferentiated ice-contact stratified drift" (IC) when detailed subsurface information is unavailable. Since kames commonly contain large amounts of fine-grained material and are characterized by considerable variability, there is generally a low to moderate probability of discovering large amounts of good quality, crushable aggregate. Extractive problems encountered in these deposits are mainly the excessive variability of the aggregate and the presence of excess fines (silt-and clay-sized particles).

Undifferentiated Ice-Contact Stratified Drift (IC): This designation may include deposits from several ice-contact, depositional environments which usually form extensive, complex landforms. It is not feasible to identify individual areas of coarse- grained material within such deposits because of their lack of continuity and grain size variability. They are given a qualitative rating based on existing pit and other subsurface data.

Outwash (OW): Outwash deposits consist of sand and gravel laid down by meltwaters beyond the margin of the glacier. The deposits occur as sheets or as terraced valley fills (valley trains) and may be very large in extent and thickness. Well developed outwash deposits have good horizontal bedding and are uniform in grain size distribution. Outwash deposited near the glacier's margin is much more variable in texture and structure. The probability of locating useful crushable aggregates in outwash deposits is moderate to high depending on how much information on size, distribution and thickness is available.

Alluvium (AL): Alluvium is a general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during postglacial time by a stream as sorted or semi-sorted sediment, on its bed or on its floodplain. The probability of locating large amounts of crushable aggregate in alluvial deposits is low, and they have generally low value because of the presence of excess silt-and clay- sized material. There are no large postglacial alluvium deposits in Ontario.

GLACIOLACUSTRINE DEPOSITS

Glaciolacustrine Beach Deposits (LB): These are relatively narrow, linear features formed by wave action at the shores of glacial lakes that existed at various times during the deglaciation of Ontario. Well developed lacustrine beaches are usually less than 20 feet (6 m) thick. The aggregate is well sorted and stratified and sand-sized material commonly predominates. The composition and size distribution of the deposit depends on the nature of the underlying material. The probability of obtaining crushable aggregate is high when the material is developed from coarse-grained materials such as a stony till, and low when developed from fine-grained materials. Beaches are relatively narrow, linear deposits, so that extractive operations are often numerous and extensive.

Glaciolacustrine Deltas (LD): These features were formed where streams or rivers of glacial meltwater flowed into lakes and deposited their suspended sediment. In Ontario, such deposits tend to consist mainly of sand and abundant silt. However, in near-ice and ice-contact positions, coarse material may be present. Although deltaic deposits may be large, the probability of obtaining coarse material is generally low.

Glaciolacustrine Plain (LP): The nearly level surface marks the floor of an extinct glacial lake. The sediments which form the plain are predominantly fine to medium sand, silt, and clay, and were deposited in relatively deep water. Lacustrine deposits are generally of low value as aggregate sources because of their fine grain size and lack of crushable material. In some aggregate-poor areas, lacustrine deposits may constitute valuable sources of fill and some granular base course aggregates.

GLACIAL DEPOSITS

End Moraines (EM): These are belts of glacial drift deposited at, and parallel to, glacier margins. They commonly consist of ice- contact stratified drift and in such instances are usually called kame moraines. Kame moraines commonly result from deposition between two glacial lobes (interlobate moraines). The probability of locating aggregate within such features is moderate to low. Exploration and development costs are high. Moraines may be very large and contain vast aggregate resources, but the location of the best areas within the moraine is usually poorly defined.

EOLIAN DEPOSITS

Windblown Deposits (WD): Windblown deposits are those formed by the transport and deposition of sand by winds. The form of the deposits ranges from extensive, thin layers to well developed linear and crescentic ridges known as dunes. Most windblown deposits in Ontario are derived from, and deposited on, pre-existing lacustrine sand plain deposits. Windblown sediments are almost invariably composed of fine to coarse sand and are usually well sorted. The probability of locating crushable aggregate in windblown deposits is very low.

Appendix D — Geology of Bedrock Deposits

(Modified after Hay (1963), Frarey (1977), Giblin and Leahy (1979) and Russell (1982))

LOWER AND MIDDLE CAMBRIAN

Rock Unit A — Jacobsville Formation: Mainly red and grey sandstone with minor inclusions of shale and conglomerate. The sandstone is a very fine to fine-grained, moderately well to well sorted red hematitic quartz arenite above a thin basal conglomerate with some green mottling and white bleached beds.

MIDDLE PROTEROZOIC

Keweenawan

Rock Unit B — Felsite, Quartz-Feldspar Porphyry: Massive red to pink porphyritic and fine-grained acidic flows which consist of orthoclase and euhedral quartz phenocrysts in a felt-like mass made up of quartz, orthoclase and minor iron oxide.

Rock Unit C — Basalt: Black and massive partly amygdaloidal and porphyritic. Plagioclase phenocrysts occur in a matrix which is composed largely of augite, hornblende and much chlorite. This rock unit may include some of Rock Unit B.

EARLY PROTEROZOIC

Rock Unit D — Nipissing Diabase: Consists dominantly of greenish or mottled grey, black and green, fine-to coarse-grained, massive quartz gabbro and diabase. Differentiated layers, pods or irregular zones of more acidic pink rock of various textures and composition are common.

Huronian Supergroup

Rock Unit E — Lorrain Formation: A very thick distinctive sequence of mainly arenites with interbeds of minor argillite, siltstone and oligomictic pebble conglomerates.

Rock Unit F — Gowganda Formation: A conglomerate with predominantly red granite boulders. Gneiss, greenstone and diabase clasts are also common. The matrix consists of fine-to coarse-grained, dark green to black wacke. Also present are finely laminated siltstone and quartzite.

Rock Unit G — Espanola and Bruce Formations: The Espanola Formation consists of alternating beds of cream-coloured limestone and grey calcareous siltstone. The Bruce Formation is a paraconglomerate consisting of pebbles and boulders of granite, granitic gneiss, greenstone and quartzite with fragments of quartz, chert, jasper, and white feldspar in a medium- to coarse-grained wacke matrix.

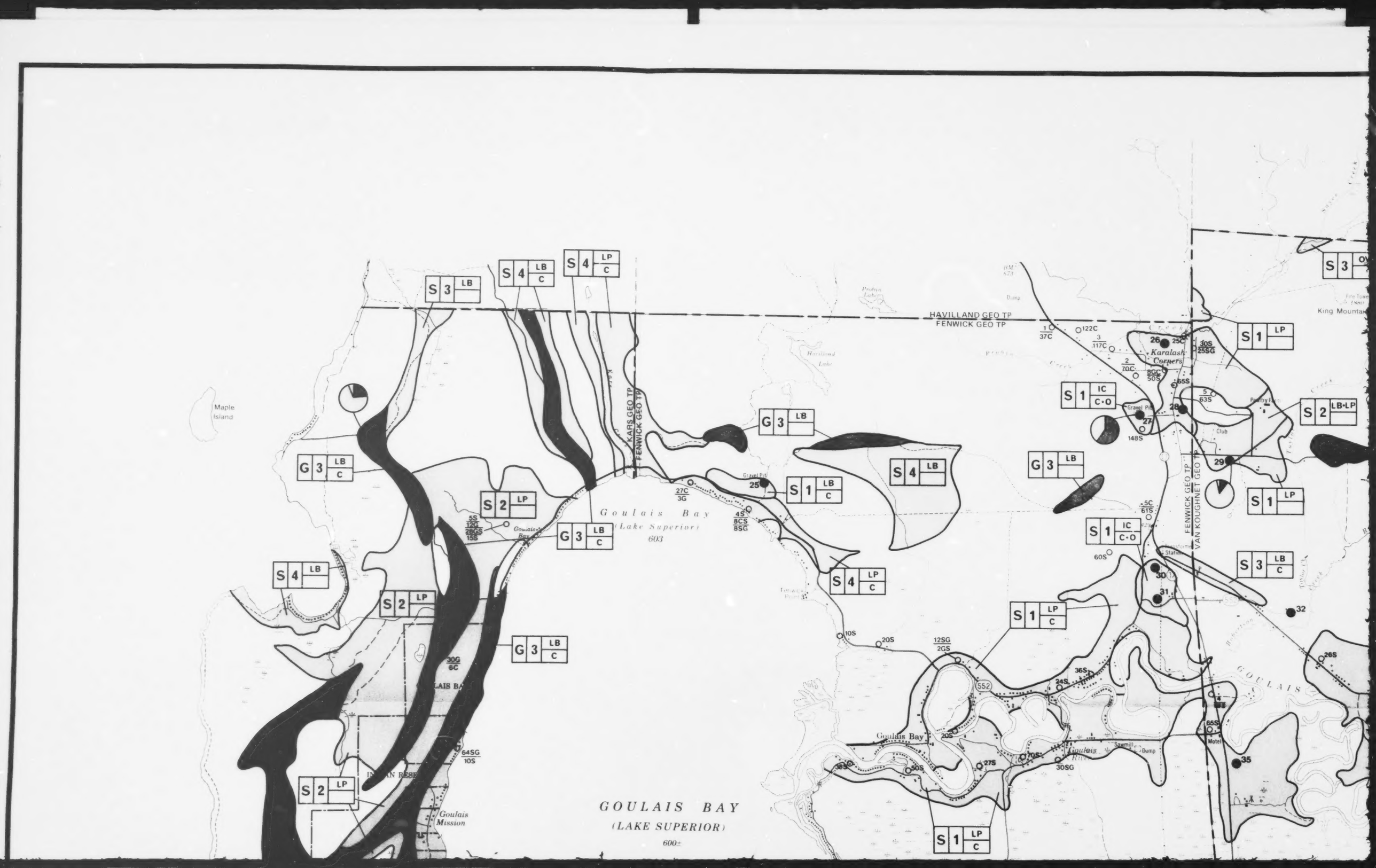
Rock Unit H — Aweres Formation: Consists predominantly of conglomerate, arkose and quartzite.

Rock Unit I — Volcanic Rocks: They include basalt, andesite, amphibolite, minor rhyolite and intercalated sedimentary rocks.

ARCHEAN

Rock Unit J — Felsic Intrusive and Metamorphic Rocks: These rocks include granite, granodiorite and diorite. They vary from pink to grey in colour and from weakly to strongly foliated and/or layered.

Rock Unit K — Mafic to Intermediate Metavolcanics: These rocks consist of mafic to intermediate flows with minor mafic pyroclastic rocks. For the most part they are hornblende and chlorite schists.


HAVILLAND GEO TP
FENWICK GEO TP
KARS GEO TP
FENWICK GEO TP
VAN KOUGHNET GEO TP
Maple Island
Goulais Bay
(Lake Superior)
603
GOULAIS BAY
(LAKE SUPERIOR)
600±
Goulais Mission
Karalash Corners
Gravel Pit
Poultry Farm
Golf Club
Motel
Sawmill
Dump
King Mountain
S 1 LP
S 1 IC C·O
S 1 LP C
S 2 LB·LP
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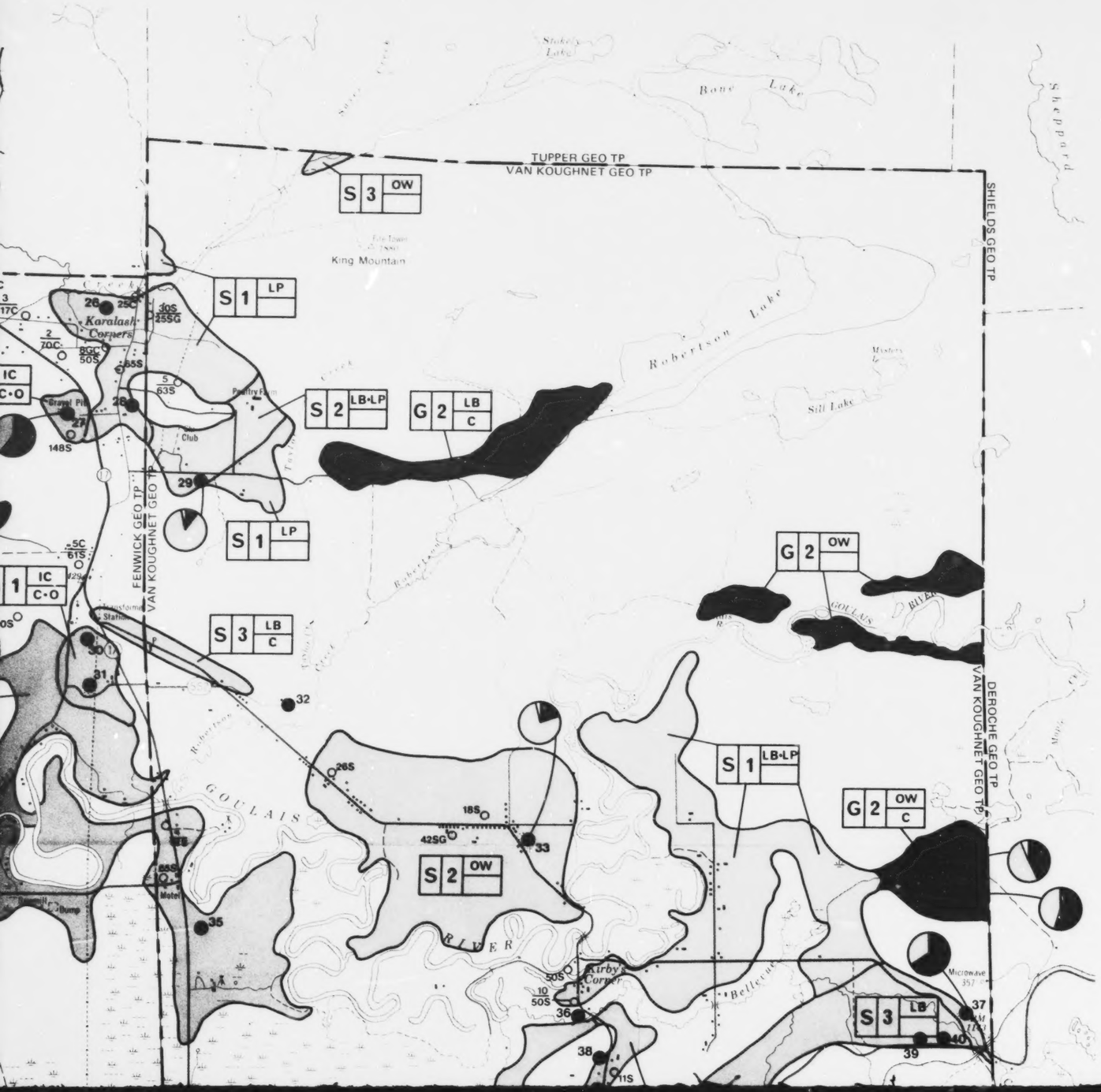
S 4 LP C
G 3 LB
G 3 LB C



Ministry of Natural Resources

Ontario

Hon. Michael Harris
Minister

Mary Mogford
Deputy Minister

ONTARIO GEOLOGICAL SURVEY

AGGREGATE RESOURCES INVENTORY

SAULT STE. MARIE AREA

ALGOMA DISTRICT

MAP 1
DISTRIBUTION OF SAND AND GRAVEL DEPOSITS

Scale 1: 50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 41 K/9
41 K/10
41 K/15
41 K/16

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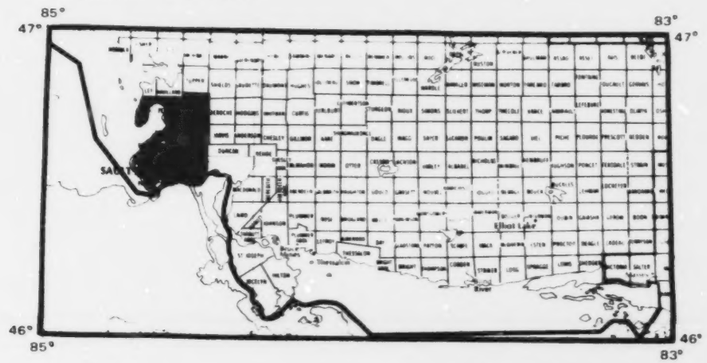

Location Map

Scale: 1 inch to 25 miles

LEGEND

(Some map units and symbols may not apply to this map.)

MAP UNITS

Gravel deposit.

Sand deposit.

KEY GEO TP
KARS GEO TP

HAVILLAND GEO TP
FENWICK GEO TP

KARS GEO TP
FENWICK GEO TP

FENWICK GEO TP
VAN KOUGHNET GEO TP

Maple Island

23

24

25

26

27

28

29

30

31

32

35

Goulais Bay
(Lake Superior)
603

GOULAIS BAY

INDIAN RESERVE

Goulais Mission

15A

GOULAIS BAY
(LAKE SUPERIOR)
600±

Goulais Bay

Goulais River

GOULAIS

Ministry of Natural Resources

Ontario

Hon. Michael Harris
Minister

Mary Mogford
Deputy Minister

ONTARIO GEOLOGICAL SURVEY

AGGREGATE RESOURCES INVENTORY

SAULT STE. MARIE AREA

ALGOMA DISTRICT

MAP 2
SELECTED SAND AND GRAVEL RESOURCE AREAS

Scale 1: 50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 41 K/9
41 K/10
41 K/15
41 K/16

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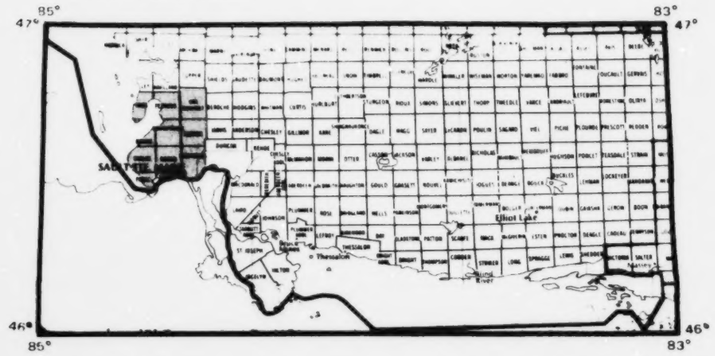

Location Map

Scale: 1 inch to 25 miles

LEGEND

MAP UNITS

(1) Selected sand and gravel resource area, primary significance; deposit number; see Table 3.

Selected sand and gravel resource area, secondary signifi-

GOULAIS BAY
(LAKE SUPERIOR)
600

Goulais Bay
(Lake Superior)
603

GOULAIS BAY

Goulais Mission

Goulais Point

Horseshoe Harbour

DENNIS GEO TP

FENWICK GEO TP

PENNEFATHER GEO TP

VAN KOUGHNET GEO TP

AWERES GEO TP

Kelly Lake

Johnson Lake

Goulais Bay

Sawmill

Dump

Motel

Trailer Park

ROAD

S 1 LP

S 1 LB C

S 1 LP C

S 1 IC C·O

S 2 LP

S 3 LB C

S 4 LB

S 4 LP C

G 3 LB C

G 2 LB

S 4 OW

NTS Reference: 41 K/9
41 K/10
41 K/15
41 K/16

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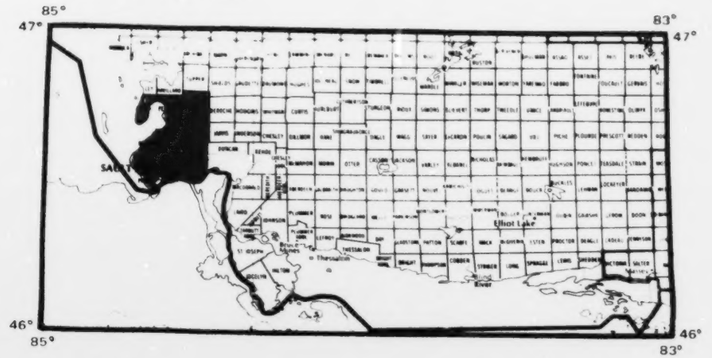

Location Map

Scale: 1 inch to 25 miles

LEGEND

(Some map units and symbols may not apply to this map.)

MAP UNITS

- Gravel deposit.
- Sand deposit.
- Gravel overlain by other surficial material.
- Sand overlain by other surficial material.
- Other surficial deposits or exposed bedrock.

SYMBOLS

- Geological and aggregate thickness boundary of sand and gravel deposits.
- Municipal, township boundary.
- 2 — Licenced property boundary; Property number: see Table 2.
- 2 — Unlicenced property boundary; Property number: see Table 2.
- Extracted area of sand and gravel pits.
- SSM-TH-2 — Test hole location; identification number; see Table 7.
- 6 / 23 G — Selected water well location. Layers of materials are described by: reported thickness of material (in feet); reported type of material (number only - overburden, G- gravel, S - sand, C - clay, T - till, B - boulders, Bk - bedrock).
- SSM-GT-2 — Geophysical traverse line; Identification number: see Table 8.
- G 1 | IC / C·O — Deposit symbol; see below.
- Texture symbol; see below; see Figures 2 to 4.

Goulais Bay
(Lake Superior)
603

GOULAIS BAY
(LAKE SUPERIOR)
600

GOULAIS BAY

INDIAN RESERVE

Goulais Mission

KARS GEO TP

DENNIS GEO TP

Horseshoe Harbour

Goulais Point

FENWICK GEO TP

PENNEFATHER GEO TP

VAN KOUGHNET GEO TP

AWREES GEO TP

GOULAIS BAY

Goulais Bay

Johnson Lake

Knife Lake

Maple Point

Island No. 14

Trout Creek Highland

Road

24

25

30

31

32

35

42

43

44

45

46

NTS Reference: 41 K/9
41 K/10
41 K/15
41 K/16

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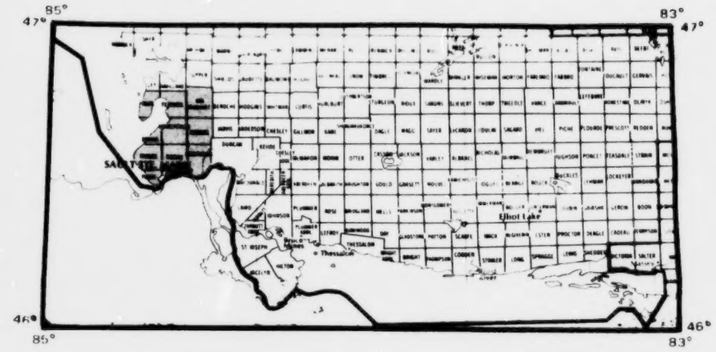

Location Map

Scale: 1 inch to 25 miles

LEGEND

MAP UNITS

(1)	Selected sand and gravel resource area, primary significance; deposit number; see Table 3.
	Selected sand and gravel resource area, secondary significance.
	Selected sand and gravel resource area, tertiary significance.

SYMBOLS

	Geological and aggregate thickness boundary of sand and gravel deposits.
	Municipal, township boundary
2	Licenced property boundary; Property number: see Table 2.
●2	Unlicenced property boundary; Property number: see Table 2.
	Extracted area of sand and gravel pits.

SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.

Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications.

Geology by: W. R. Cowan, 1976, in prep.
O. Hungr and J. A. Franklin, 1977.
D. F. McQuay, 1980.
J. E. Sniezek, 1976.

Additional Fieldwork by: Staff of the Aggregate Assessment Office.

Compilation and Drafting by: Staff of the Aggregate Assessment Office.

This map is to accompany O.G.S. Aggregate Resources Inventory Paper 120.

This map is published with the permission of V. G. Milne, Director, Ontario Geological Survey.
Issued 1985.

N
G O U L A I S B A
S 4 LB
S 3 LB C
S 3 LB C
DENNIS GEO TP
CORPORATION of the TOWNSHIP of PRINCE
PENNEFATHER GEO TP
DENNIS GEO TP
CITY of SAULT STE. MARIE
CORP of the TP of PRINCE
PENNEFATHER GEO TP
CITY of SAULT STE. MARIE
S 4 OW
AWERES GEO TP
PENNEFATHER GEO TP
S 3 OW
G 1 OW
S 2 OW
G 2 OW
G 1 LB·LD
S 2 OW
G 1 LB·LD
G 1 LB·LD
G 3 OW
S 1 LB
S 1 LB
S 1 LB
S 1 LP
S 1 LP
S 3 OW
S 3 LP
S 2 LP
S 1 LB
S 3 LB
S 1 LB
S 2 OW
G 1 LB·LD
S 1 LB
S 1 LP
S 3 LB
North Gros Cap
Prince Lake
Walls Lake
Jackson Island
Radio 110
Mushroom Farm
Fort Creek Conservation Area
Golf Course
Trans Sta
SSM·GT·5
SSM·TH·1
SSM·TH·2
SSM·TH·3
SSM·TH·6
SSM·TH·8
SSM·TH·11
SSM·TH·14
SSM·TH·15
Kelly Lake
Johnson Lake
Bennett Road
Carp Creek
Fort Creek
Dacotah Creek
East Korah Road
Korah Road
Trunk Road
Old Garden River Road
Base Line Road
Second Line Road
Third Line Road
Fourth Line Road
Fifth Line Road
Sixth Line Road
Seventh Line Road
Eighth Line Road
Ninth Line Road
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Eleventh Line Road
Twelfth Line Road
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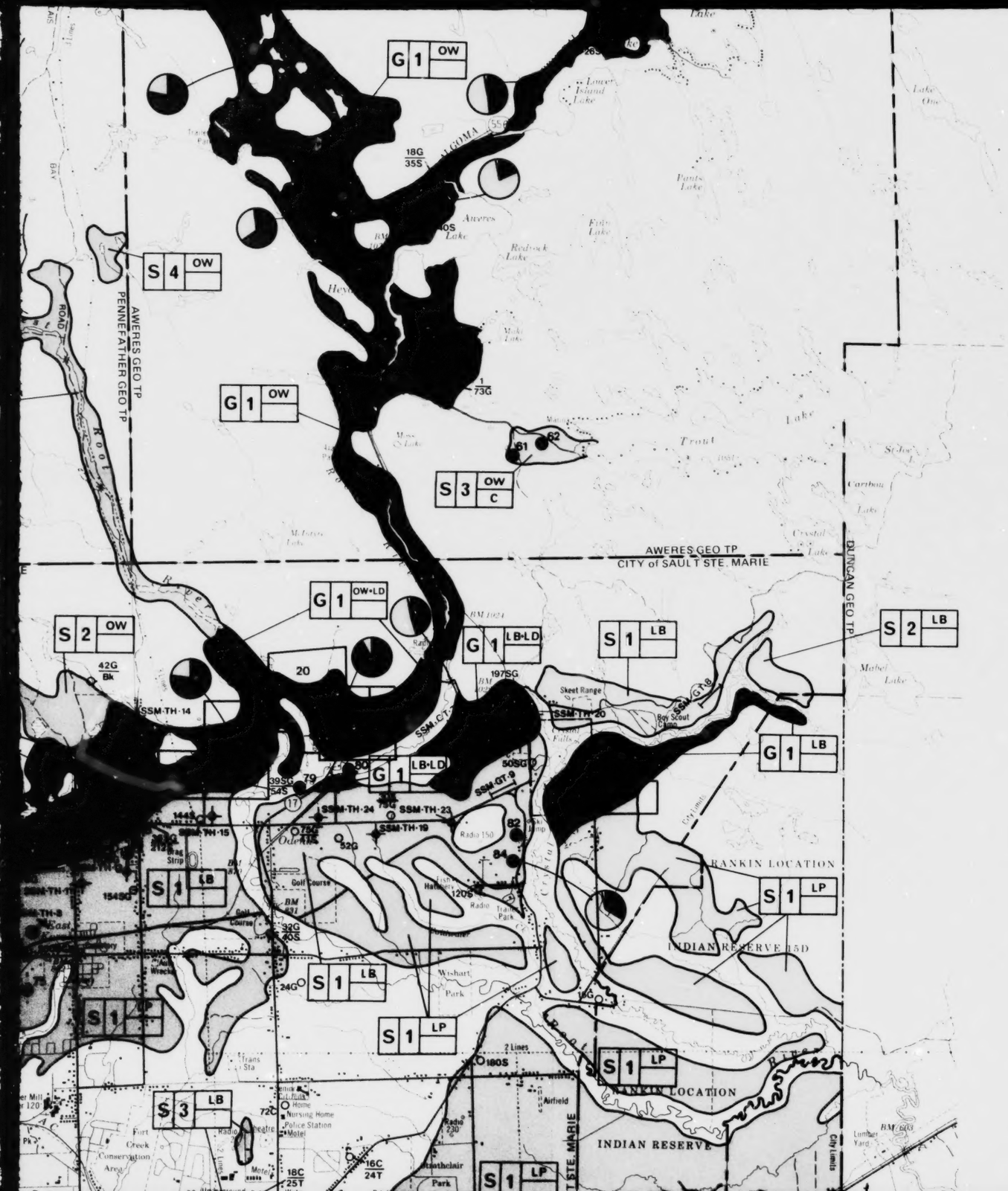
Ninety-Sixth Line Road
Ninety-Seventh Line Road
Ninety-Eighth Line Road
Ninety-Ninth Line Road
One Hundredth Line Road



2 — Licenced property boundary; Property number: see Table 2.

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Extracted area of sand and gravel pits.

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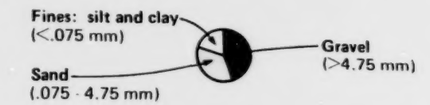
SSM-GT-2 — Geophysical traverse line; Identification number: see Table 8.

G 1 IC / C•O — Deposit symbol; see below.

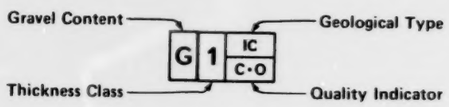
Texture symbol; see below; see Figures 2 to 4.

TEXTURE SYMBOL



The Texture Symbol provides quantitative assessment of the grain size distribution at a sampled location. The relative amounts of gravel, sand, silt and clay in the sampled material are shown graphically by the subdivision of a circle into proportional segments. The above example shows a hypothetical sample consisting of 45% gravel, 35% sand and 20% silt and clay.

DEPOSIT SYMBOL



Deposits are identified by Gravel Content, Thickness Class, Geological Type and Quality Indicator. Gravel Content is expressed as a percentage of gravel-sized material (i.e. material retained on the 4.75 mm sieve.). Thickness Class is based on potential aggregate tonnage per acre. Geological Type refers to geologic origin. Quality Indicator describes objectionable grain size and lithology.

Gravel Content

G	Greater than 35% gravel.
S	Less than 35% gravel.

Thickness Class

Class	Average Thickness in Feet (Metres)	Tons per Acre	Tonnes per Hectare
1	greater than 20 (>6)	greater than 50,000	greater than 112 000
2	10 - 20 (3 - 6)	25,000 - 50,000	56 000 - 112 000
3	5 - 10 (1.5 - 3)	12,500 - 25,000	28 000 - 56 000
4	less than 5 (<1.5)	less than 12,500	less than 28 000

Geological Type

AL	Older Alluvium	**K**	Kame
E	Esker	**LB**	Lacustrine Beach
EM	End Moraine	**LD**	Lacustrine Delta

GOULAIS BAY

PENNEFATHER GEO TP
DENNIS GEO TP

DENNIS GEO TP
CORPORATION of the TOWNSHIP of PRINCE

PENNEFATHER GEO TP
CITY of SAULT STE MARIE

AWEres GEO TP
PENNEFATHER GEO TP

CITY of SAULT STE. MARIE
CORP of the TP of PRINCE

ROCK

North Gros Cap

Prince Lake

Walls Lake

Jackson Island

Algard Lake

Northern Lake

Church Camp

Radio 200°

Rifle Range

Mushroom Farm

Fort Creek Conservation Area

1b

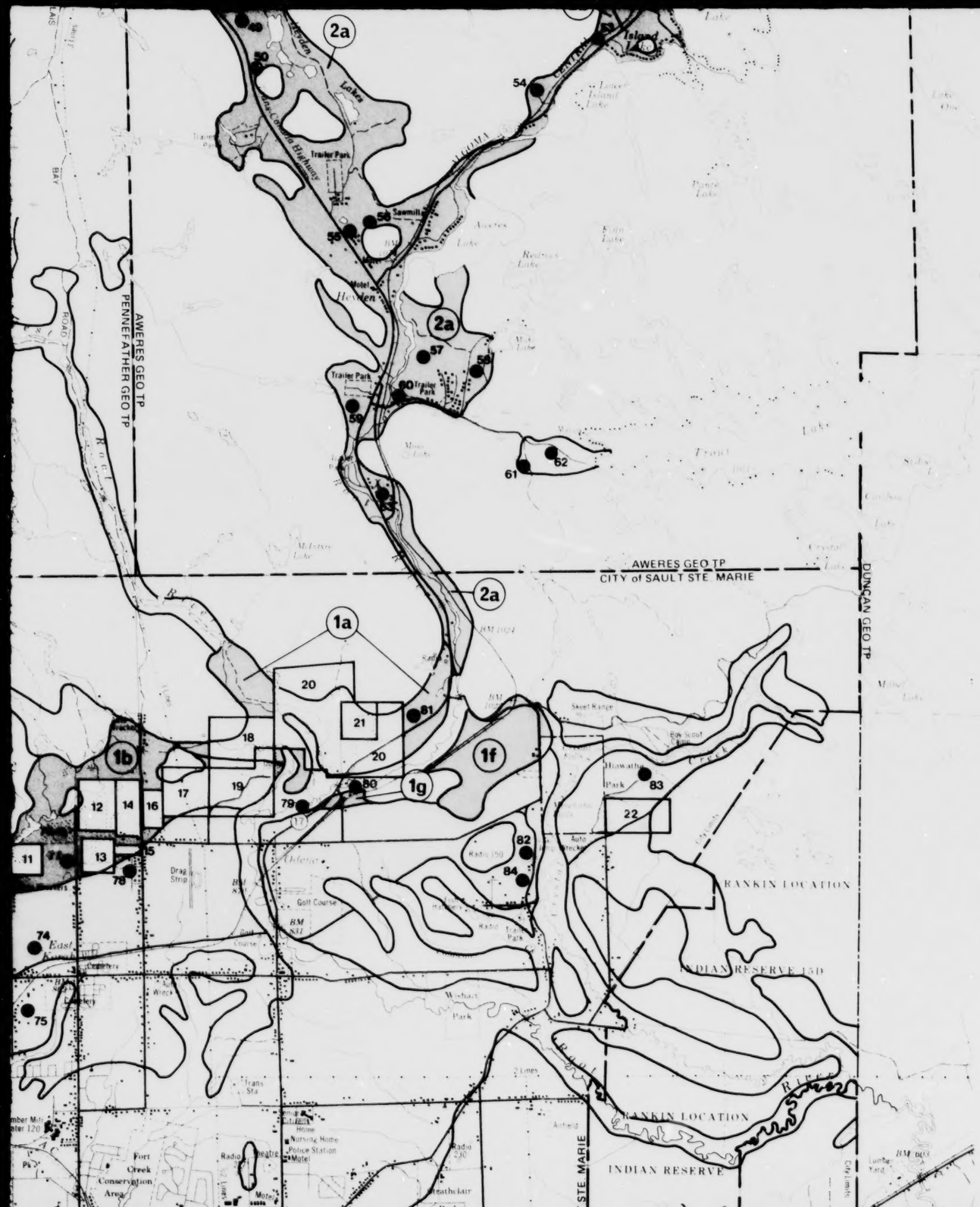
1c

1d

1e

2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

65 67 70 72 73 74 75 76 77 78 79



Extracted area of sand and gravel pits.

SOURCES OF INFORMATION

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Compilation and Drafting by: Staff of the Aggregate Assessment Office.

This map is to accompany O.G.S. Aggregate Resources Inventory Paper 120.

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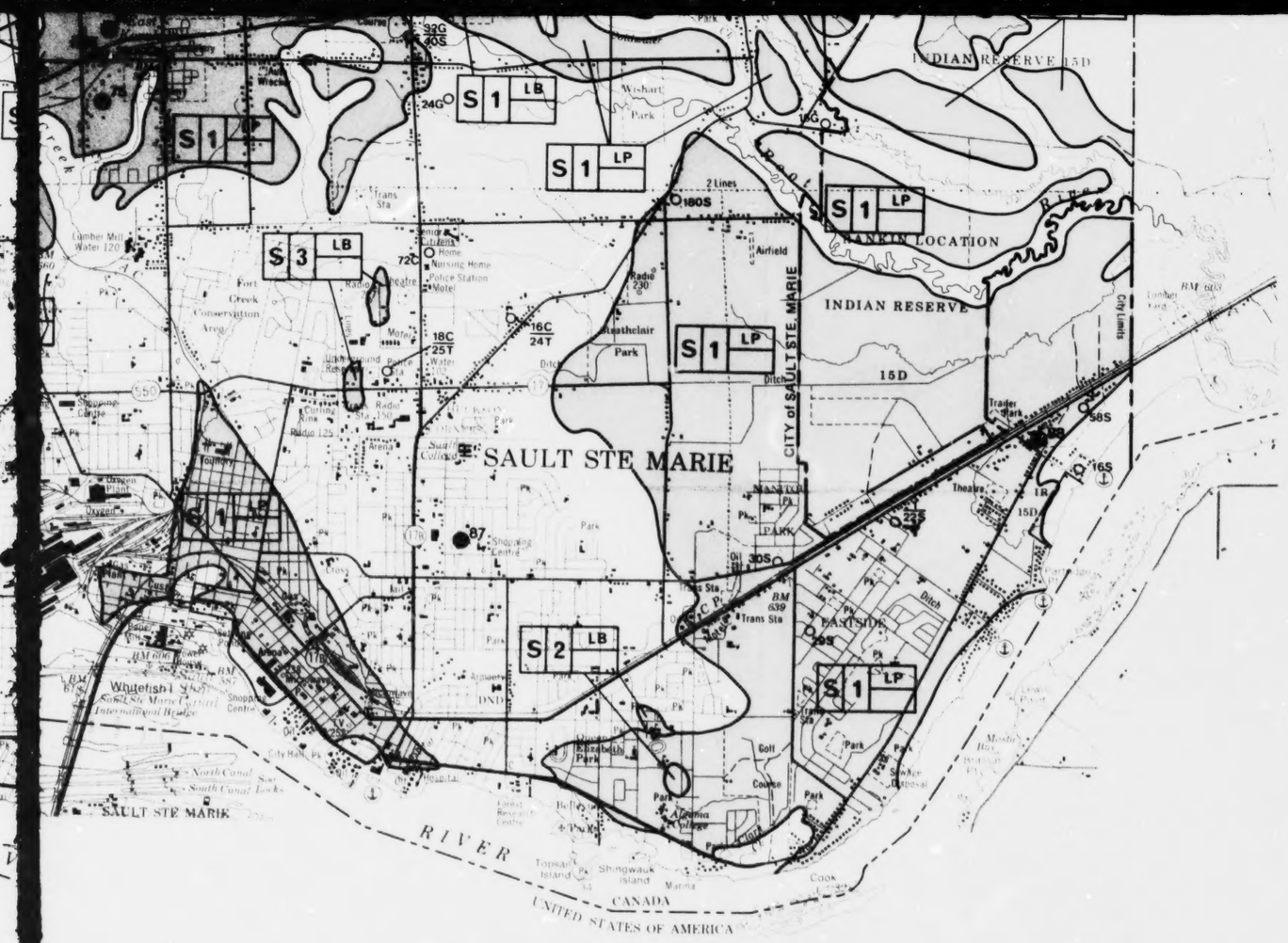
Issued 1985.

Gros Cap
Prince Lake
Walls Lake
Jackson Island
Radio 110
G 3 OW
G 2 LB
S 1 LP
S 3 LB
10SG 40S
160S
Gros Cap
BM 627
Radio
Wharf
Cemetery
153S
46 30S
550
S 1 LB
ST MARYS RIVER
Chene Island
CORP. of the TP of PRINCE
CITY of SAULT STE. MARIE
17S
565
S 3 WD-LP
S 1 LP
Sault Ste Marie Airport
85
40S
Airport Limits
1
1
S 3 LP
G 3 OW
6G
Carp River
BM 639
18S
55S
Mary Ann Lake
BM 613
50S
Water
Pointe des Chenes Park
52S
5SG 80S
48SG
Sault Ste Marie Airport
35S
S 1 LP
10S
Gas
1G 67S
30S
ST MARYS RIVER
G 1 LB-LD
S 1 LB
65
20
SECOND
WEST
10S
S 3 LP
S 2 LP
76C
51C
S 4 LP
86
Carpin Beach
25SG
Pointe aux Pins
Bay
2 63SG
60S
55S
3S 50C
Leigh Bay
ST MARYS
ALGOMA DISTRICT
CHIPPEWA COUNTY
CANADA
UNITED STATES OF AMERICA
ONTARIO
MICHIGAN
BM 608
Shallows
Brush Point
Sault Ste Marie City Limits
Munuscong State Forest
G 1
S 1 LB
S 3 OW
S 3 LP
S 2 LP
S 1 LP
S 1 LB
S 3 LB
S 1 LP
S 1 LP
S 3 LB
S 2 LP
S 1 LP
SSM-TH-8
SSM-TH-6
SSM-TH-3
SSM-TH-2
SSM-TH-1
141S
162S
130S
70S
85G 53S
168S 30G 10S
70S
30S
300C 14GS
7C
40C 43S
18S
Auto Wrecker
Mushroom Farm
Transformer Station
275
7SG
3S 50C
16S
Golf Course
Fort Creek Conservation Area
Pt
Pk
Ps
Ruins
Tower
Quarry
Gravel Pit
Tailings
Pond
Compressor Station
Auto Wrecker
Tourism
Whitefish Lake
Amusement Park
Rifle Range
DNT



Thickness Class

Class	Average Thickness in Feet (Metres)	Tons per Acre	Tonnes per Hectare
1	greater than 20 (>6)	greater than 50,000	greater than 112 000
2	10 - 20 (3 - 6)	25,000 - 50,000	56 000 - 112 000
3	5 - 10 (1.5 - 3)	12,500 - 25,000	28 000 - 56 000
4	less than 5 (<1.5)	less than 12,500	less than 28 000

Geological Type

AL	Older Alluvium	K	Kame
E	Esker	LB	Lacustrine Beach
EM	End Moraine	LD	Lacustrine Delta
IC	Undifferentiated Ice-Contact Stratified Drift	LP	Lacustrine Plain
		OW	Outwash
ICT	Ice-Contact Terrace	WD	Windblown Forms

(see Appendix C for descriptions of Geological Types)

Quality Indicator

If blank, no known limitations present.

C	Clay and/or silt (fines) present in objectionable quantities.
L	Deleterious lithologies present.
O	Oversize particles or fragments present in objectionable quantities.

SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.

Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications and Deike (1983).

Selected water well data from the Ontario Ministry of the Environment.

Test hole data from Aggregate Assessment Office, Ontario Geological Survey, Ontario Ministry of Natural Resources; Ontario Ministry of Transport and Communications; other sources (see Table 7).

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Information quoted for an individual test hole or pit refers to a specific sample or face. Care should be exercised in extrapolating such information to other parts of the deposit.

Prince Lake

Walls Lake

Jackson Island

Radio 110 180 110

Gros Cap

Radio

Wharf

Cemetery

550

CORP. of the TP of PRINCE
CITY of SAULT STE. MARIE

Carp River

SECOND LINE WEST

ST MARYS RIVER

Chêne Island

1

1

Airport Limits

Sault Ste Marie Airport

Pointe des Chênes Park

565

Water

Gas

Pointe aux Pins Bay

Carpin Beach

Leigh Bay

Pointe aux Pins

Shallows

Sault Ste Marie City Limits

Munuscong State Forest

ALGOMA DISTRICT
CHIPPEWA COUNTY

CANADA
UNITED STATES OF AMERICA

ONTARIO
MICHIGAN

ST MARYS

SAULT STE MARIE

1c

1d

1e

2

3

4

5

6

7

8

9

10

65

66

67

68

69

70

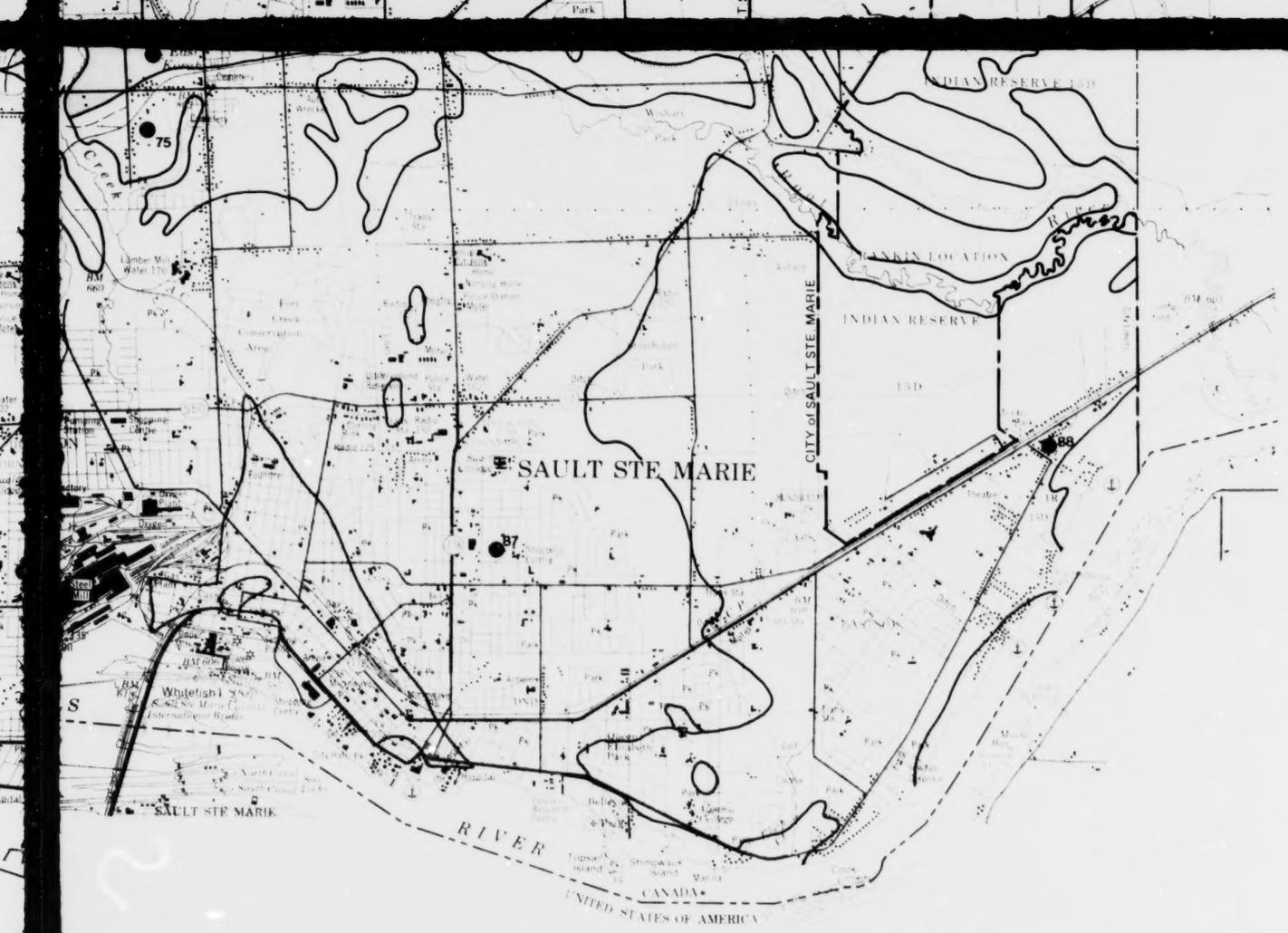
71

74

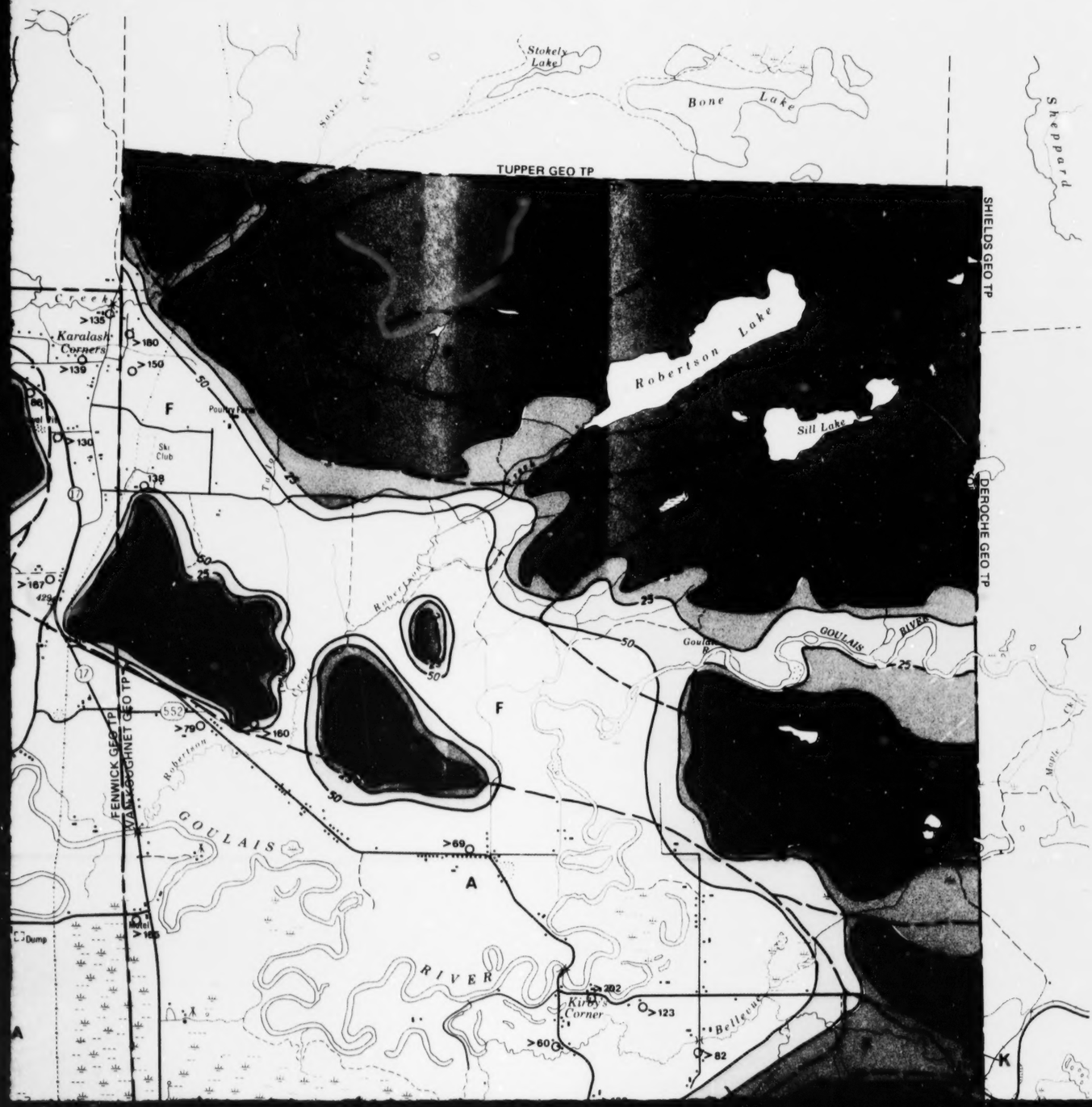
75

85

86


SAULT STE MARIE
CITY of SAULT STE MARIE
INDIAN RESERVE 15D
INDIAN LOCATION
INDIAN RESERVE
15D
75
87
88
Whitefish I.
SAULT STE MARIE
RIVER
CANADA
UNITED STATES OF AMERICA

LEY GEO TP
KARS GEO TP
HAVILLAND GEO TP
FENWICK GEO TP
WAKEHAM GEO TP
Maple Island
Kars Creek
Havilland
Proven Lake
Dump
Gravel Pit
Karalash Corners
Ski Club
Goulais Bay
(Lake Superior)
603
Goulais Bay
Goulais Mission
INDIAN RESERVE
GOULAIS BAY
GOULAIS BAY
(LAKE SUPERIOR)
600
Goulais River
Sawmill
A
E
F
>31
>30
>122
138
>135
>180
>139
>150
86
>130
>167
42%
>79
>160
45
64
165
167
175
158
203
170
>67
>165
552
552
552



Ministry of Natural Resources

Ontario

Hon. Michael Harris
Minister

Mary Mogford
Deputy Minister

ONTARIO GEOLOGICAL SURVEY

AGGREGATE RESOURCES INVENTORY

SAULT STE. MARIE AREA

ALGOMA DISTRICT

MAP 3
BEDROCK RESOURCES

Scale 1: 50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 41 K/9
41 K/10
41 K/15
41 K/16

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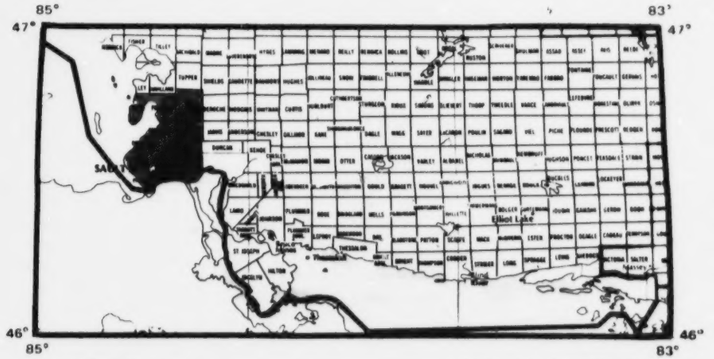


Location Map

Scale: 1 inch to 25 miles

LEGEND

DRIFT THICKNESS

Goulais Bay
(Lake Superior)
603

GOULAIS BAY
(LAKE SUPERIOR)
600

GOULAIS BAY

GOULAIS BAY

INDIAN RESERVE

15A

Goulais Mission

KARS GEO TP
DENNIS GEO TP

Horseshoe Harbour

Goulais Point

Maple Point

Kells Lake

Goulais Bay

Goulais River

Gravel Pit

Swamp

Dump

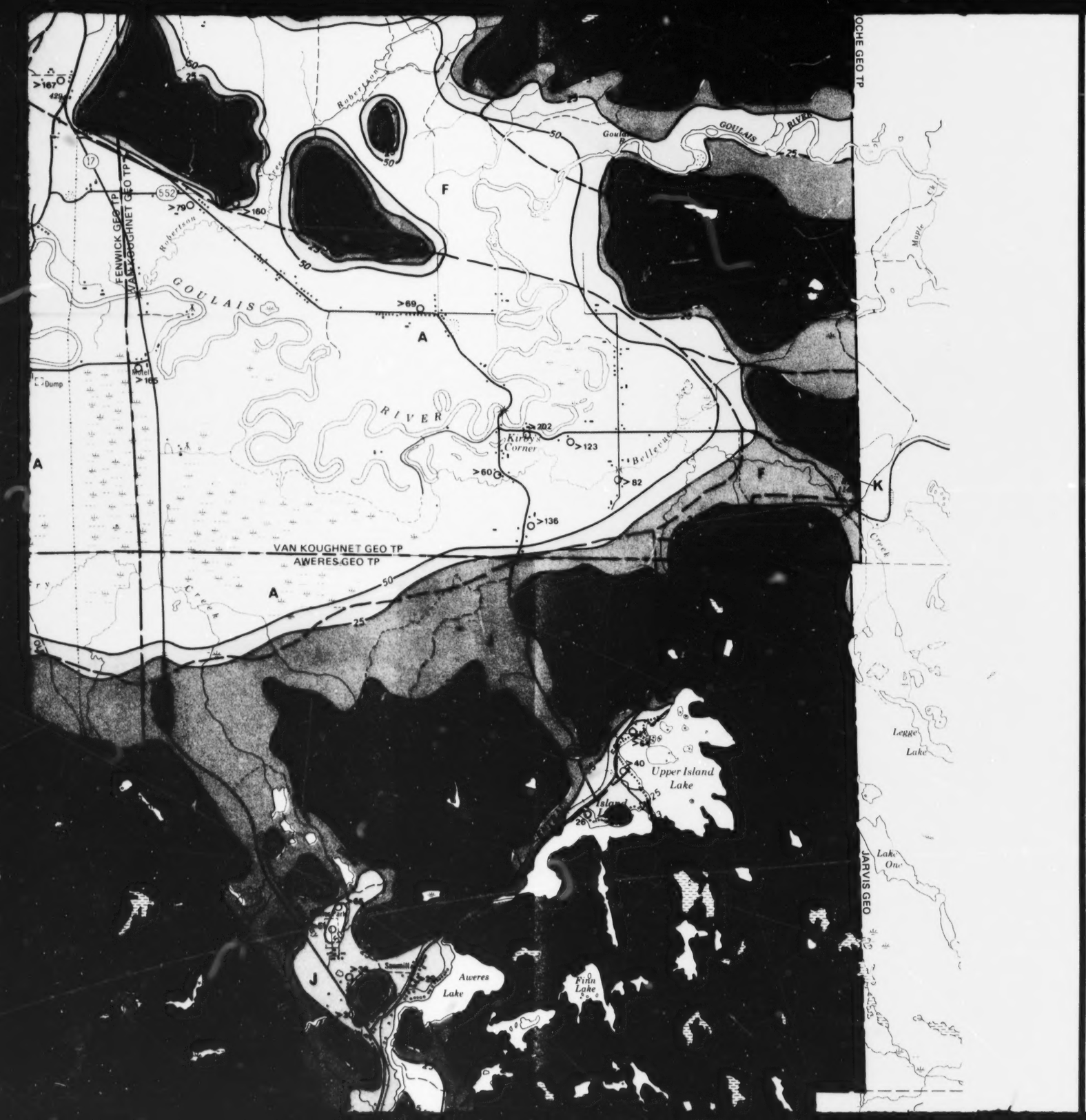
FENWICK GEO TP
PENNEFATHER GEO TP

FENWICK GEO TP
VAN KOUGHNET GEO TP

VAN KOUGH
AWERES

A

J



Scale 1: 50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 41 K/9
41 K/10
41 K/15
41 K/16

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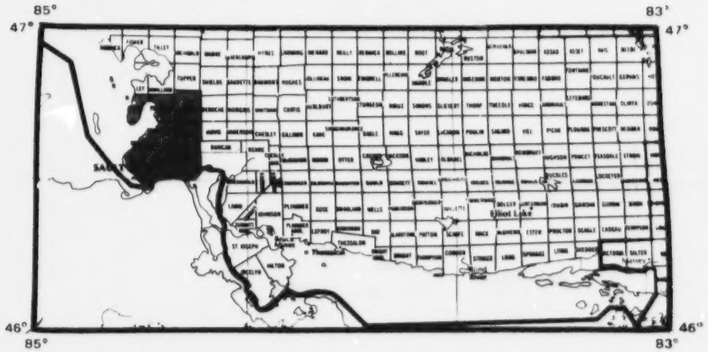


Location Map

Scale: 1 inch to 25 miles

LEGEND

DRIFT THICKNESS

Bedrock outcrop: areas of exposed bedrock partially covered by an irregular veneer of drift. Drift thickness is generally less than 3 feet (1 m); see Table 4.

Bedrock drift complex: areas of bedrock covered by an irregular veneer of drift. Drift thickness is generally less than 25 feet (8 m) but may exceed 65 feet (20 m) in bedrock depressions. Isolated bedrock outcrops may occur; see Table 4.

Drift-covered bedrock: areas of bedrock generally covered by 25 to 50 feet (8 to 16m) of drift. The areas contain isolated outcrops and small areas of thin drift as well as local areas of considerably thicker drift.

Drift-covered bedrock: areas of bedrock generally covered by more than 50 feet (16m) of drift.

BEDROCK UNITS

PHANERZOIC

PALEOZOIC

CAMBRIAN

Lower and Middle Cambrian

A Jacobsville Formation
Sandstone, siltstone, shale, conglomerate

PRECAMBRIAN

MIDDLE PROTEROZOIC

Keweenawan

Felsic Intrusive and Volcanic Rocks

B Felsite, quartz - feldspar porphyry

Mafic Volcanic Rocks

C Basalt

EARLY PROTEROZOIC

Nipissing Diabase

GOULAIS BAY

Kelly Lake

North Gros Cap

Prince Lake

Jackson Island

Dump

Church Camp

Radio 700

Auto Wreckers

Drag Strip

Golf Course

Ball Park

Amusement Park

Auto Wrecker

Tree Nursery

DND Rifle Range

Trans Sta

Lumber Mill

Water 120

Mushroom Farm

Fort Creek Conservation Area

Theatre

Radio

Nursing Home

Police Station

Dunbar Creek

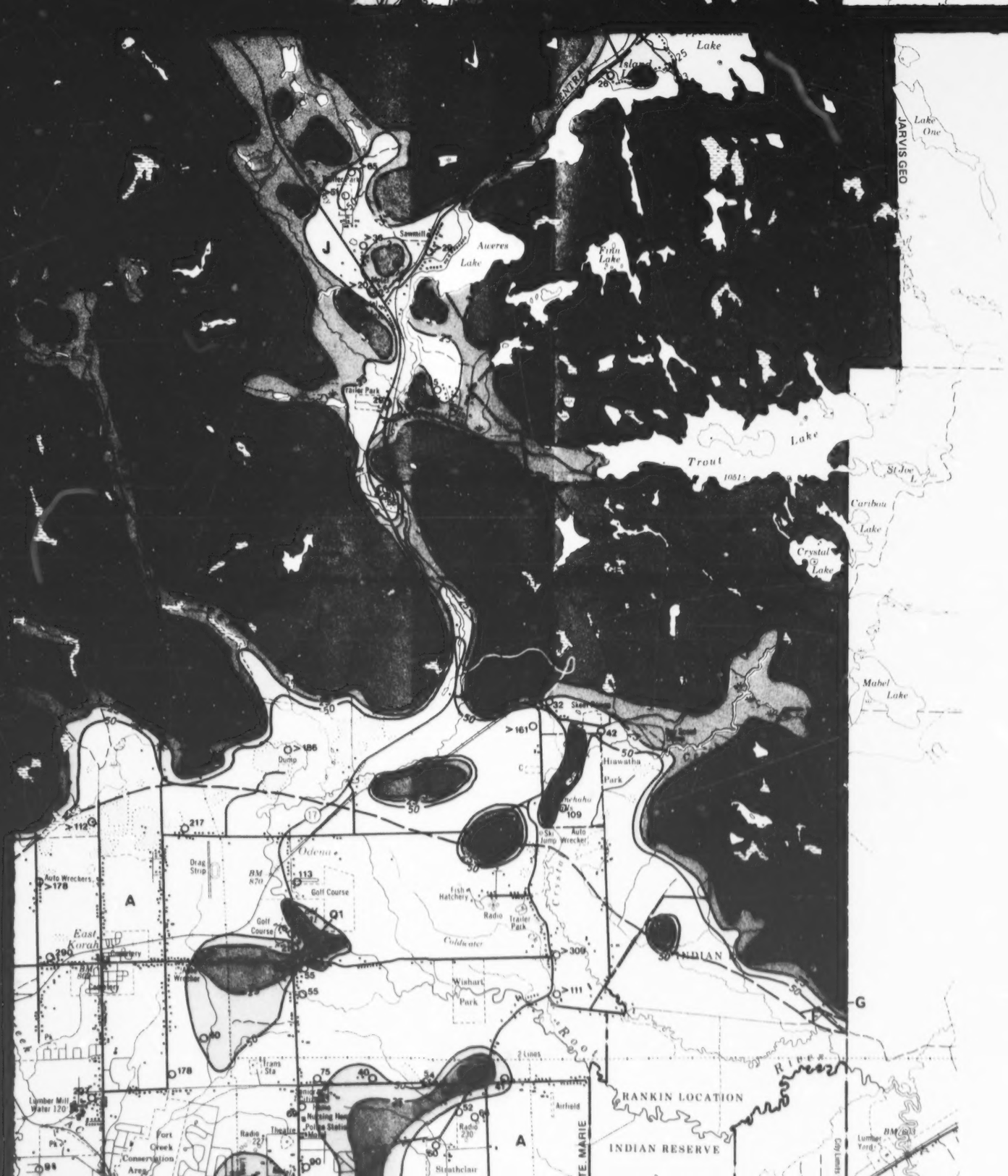
Korah West

Korah

Delano

J

A



BEDROCK UNITS

PHANERZOIC

PALEOZOIC

CAMBRIAN

Lower and Middle Cambrian

A Jacobsville Formation
Sandstone, siltstone, shale, conglomerate

PRECAMBRIAN

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Keweenawan

Felsic Intrusive and Volcanic Rocks

B Felsite, quartz - feldspar porphyry

Mafic Volcanic Rocks

C Basalt

EARLY PROTEROZOIC

Nipissing Diabase

D Diabase, gabbro, metagabbro, granophyre

Huronian Supergroup

Cobalt Group

E Lorrain Formation
Quartzite, arkose, conglomerate

F Gowganda Formation
Conglomerate, argillite, greywacke, quartzite, siltstone

Quirke Lake Group

G Espanola and Bruce Formations
Limestone, dolomite, calcareous siltstone, conglomerate

Hough Lake Group

H Aweres Formation
Conglomerate, arkose, quartzite

Volcanic Rocks

I Basalt, andesite, amhibolite, minor rhyolite and intercalated sedimentary rocks

ARCHEAN

Felsic Intrusive and Metamorphic Rocks

J Unsubdivided granitic and migmatitic rocks

Metavolcanics

K Mafic to intermediate metavolcanics unsubdivided

SYMBOLS

(1) Selected bedrock resource area; deposit number; see Table 6.

Geological boundary.

25 Drift thickness contour (3-foot, 25-foot and 50-foot contours are shown).

Municipal, township boundary.

Q2 Licenced quarry boundary; Property number: see Table 5.

x Isolated bedrock outcrop.

O 24 Selected water well location; reported depth to bedrock (in feet).

SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.

Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications.

Prince Lake

Jackson Island

Gros Cap

Wharf

Cemetery

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CORP of the TP of PRINCE
CITY of SAULT STE. MARIE

Chêne Island

Sault Ste Marie Airport

Carpin Beach

Mary Ann Lake

Airport Limits

Water

Pointe des Chênes

Pointe des Chênes Park

Pointe aux Pins

Pointe aux Pins Bay

ST MARYS RIVER

ONTARIO
MICHIGAN
UNITED STATES OF AMERICA
CANADA

ALGOMA DISTRICT
CHIPPEWA COUNTY

Sault Ste Marie City Limits

Brush Point

Shallows

Munuscong State Forest

SECOND LINE WEST

Motel

Auto Wrecker

Mushroom Farm

Transformer Station

Tree Nursery

Ball Park

Amusement Park

DND Rifle Range

Lumber Mill

Fort Creek Conservation Area

Underground Reservoir

Police Stn

Trans Sta

Gas Pipeline

Compressor Station

Slag Heap

Old Vessel Point

Leigh Bay

ST MARYS

ALGOMA DISTRICT
CHIPPEWA COUNTY
ST MARYS FALLS CANAL

North Canal
South Canal Locks

SAULT STE MARIE

Whitefish Bay

Sault Ste Marie International Bridge

Shopping Centre

City Hall

RIV

Carp River

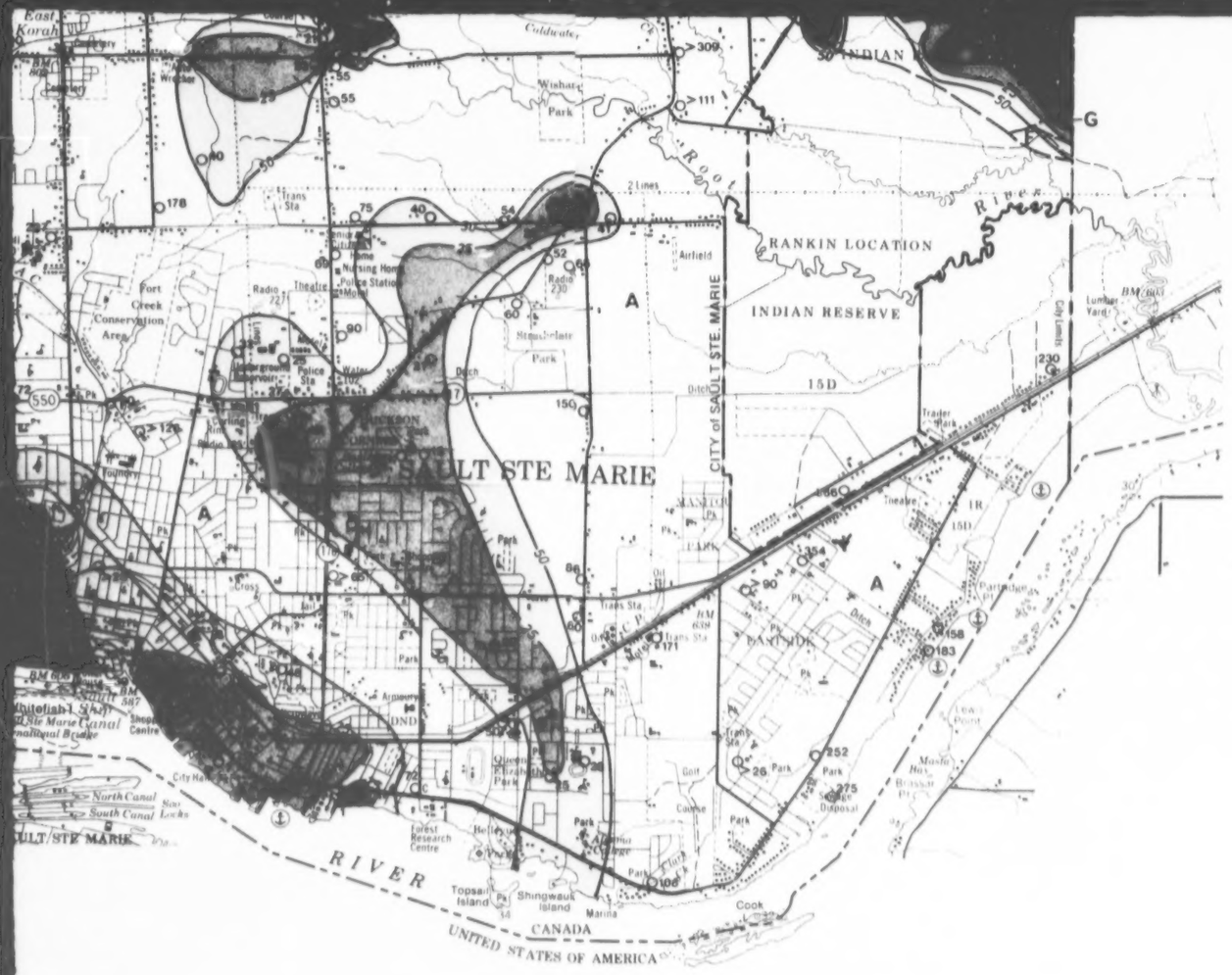
Little Carp River

Creek

Ditch

City Limits

Sault Ste Marie City Limits



contours are shown).

Municipal, township boundary.

Q2 — Licenced quarry boundary; Property number: see Table 5.

x — Isolated bedrock outcrop.

O 24 — Selected water well location; reported depth to bedrock (in feet).

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M. J. Frarey, 1977.
P. E. Giblin and E. J. Leahy, 1976, 1979.
E. J. Leahy and P. E. Giblin, 1979.

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